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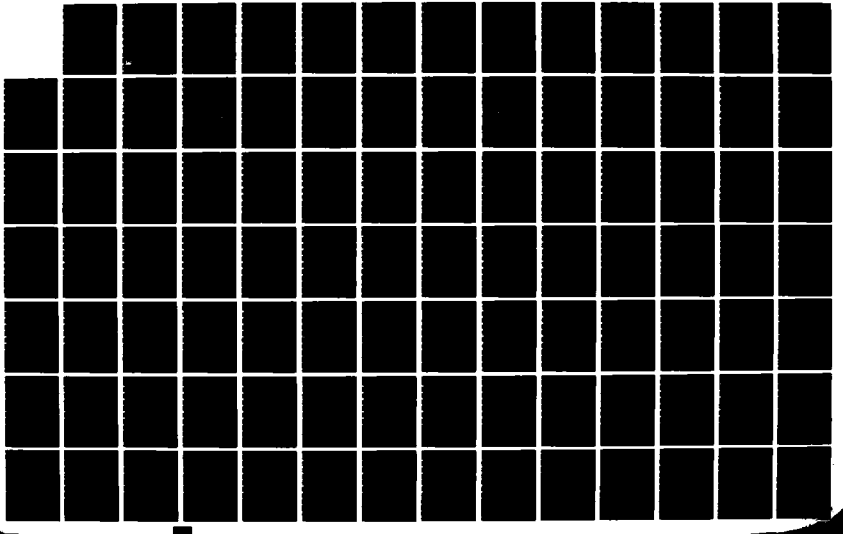

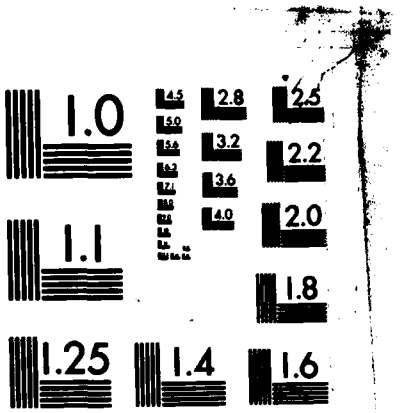

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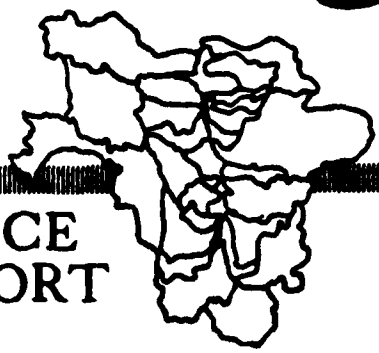

RECONNAISSANCE REPORT

BUFFALO RIVER SUBBASIN

FINAL REPORT
December 1980

ST. PAUL DISTRICT: U.S. ARMY CORPS OF ENGINEERS

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This report is one of 23 subbasin reports produced by the St. Paul District Corps of Engineers in connection with a reconnaissance report for the whole of the Red River Basin. The reconnaissance report is itself part of the overall Red River of the North study, which was initiated by Congress in 1957 in order to develop solutions for flooding problems within the basin.

The purpose of a reconnaissance study is to provide an overview of the water and related land resource problems and needs within a particular geographic area, to identify planning objectives, to assess potential solutions and

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problems, to determine priorities for immediate and longrange action, and to identify the capabilities of various governmental units for implementing the actions.

The information developed in this report has been combined with information developed in the other subbasin reports to produce a main report covering the basin as a whole. The various flood control measures discussed in this and in other subbasin reports are combined in the main report to develop the outline of an integrated flood control plan for the basin within the context of a comprehensive plan.

The Buffalo River Subbasin occupies 1,189 square miles of the southern Minnesota portion of the Red River Basin and covers portions of the counties of Wilkin, Clay, Becker and Ottertail. Most of the land in the subbasin has been cleared for agriculture, although there are some large forest tracts in the eastern extremity, which reaches into the White Earth Indian Reservation. Surface water features include lakes, streams, ditches, creeks and potholes. The dominant water feature is the Buffalo River, which begins in Tamarac Lake in Becker County.

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RECONNAISSANCE REPORT: RED RIVER OF THE NORTH BASIN, BUFFALO RIVER SUBBASIN

Prepared for:

U.S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota

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The purpose of a reconnaissance study is to provide an overview of the water and related land resource problems and needs within a particular geographic area, to identify planning objectives, to assess potential solutions and problems, to determine priorities for immediate and long-range action, and to identify the capabilities of various governmental units for implementing the actions.

The Buffalo River Subbasin is a water resource planning unit located in the southern Minnesota portion of the Red River Basin. This report describes the social, economic, and environmental resources of the subbasin, identifies the water-related problems, needs, and desires, and suggests measures for meeting the needs, particularly in the area of flood control.

The report was prepared almost entirely on the basis of secondary information. However, some telephone contacts were made to verify information and to acquire a more complete picture of local conditions. The only comprehensive reports available on the subbasin are the 1979 Buffalo-Red River Watershed appendix to the District Overall Plan, which was published by the Buffalo-Red River Watershed District, and the 1971 Transcript of Minutes of Mid-Study Public Meeting on Water Management Alternatives, Buffalo River Subbasin, which was published by the St. Paul District Corps of Engineers. Other published sources on the subbasin include:

1. Work Plan for South of Hawley-South Buffalo Watershed, which was published by the U.S. Soil Conservation Service in 1961 and outlines a plan to alleviate flooding and improve surface drainage in a 236 square mile area in the central portion of the subbasin.

2. Interim Survey for Flood Control and Related Purposes, Buffalo River, Minnesota, which was published in 1971 by the St. Paul District Corps of Engineers and is a plan of survey of flooding problems along the Buffalo River.

In addition, the subbasin received partial coverage in the Souris-Red-Rainy River Basins Comprehensive Study, which was published by the Souris-Red-Rainy River Basins Commission in 1972, and in the Red River of the North Basin Plan of Study, which was published by the St. Paul District Corps of Engineers in 1977.

The information developed in this report has been combined with information developed in the other subbasin reports to produce a main report covering the basin as a whole. The various flood control measures discussed in this and in other subbasin reports are combined in the main report to develop the outline of an integrated flood control plan for the basin within the context of a comprehensive plan. The main report will consider the possibility of various water resource oriented agencies serving as vehicles for implementing flood damage reduction actions and undertaking additional study needs.

II. DESCRIPTION OF STUDY AREA

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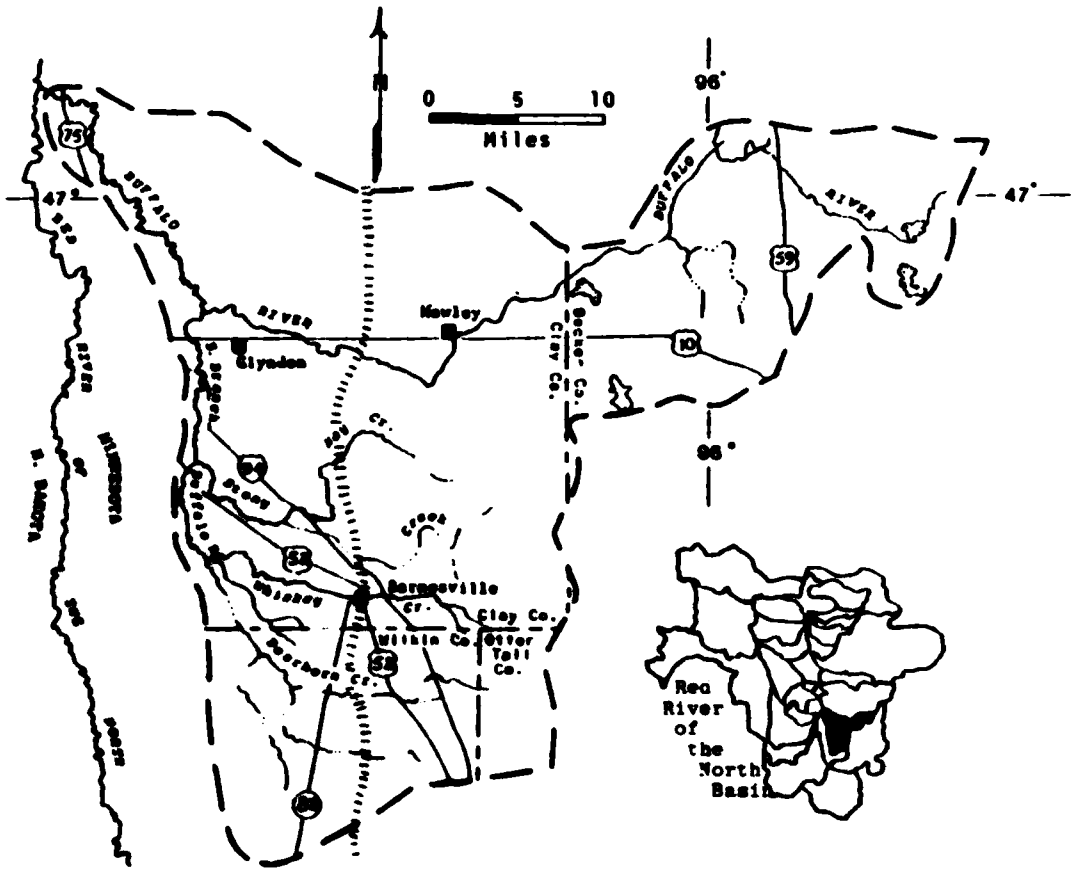
The Buffalo River Subbasin (Figure I) occupies 1,189 square miles of the southern Minnesota portion of the Red River Basin and covers portions of the counties of Wilkin, Clay, Becker, and Ottertail. It is bordered on the north by the Wild Rice-Marsh River Subbasin, on the east by the Ottertail River Subbasin, and on the south and west by the Main Stem Subbasin. The subbasin has attained a legal status through the formation of the Buffalo-Red River Watershed District.

Like many other areas in the Red River Basin, the subbasin can be divided into three distinct physiographic regions: the glacial Lake Agassiz bed deposits, the beach ridge area, and the glacial moraine. The western portions of Clay and Wilkin counties are occupied by the lake bed, which is characterized by level deposits of sediments up to 80 feet in thickness. To the east of the lake bed, beach ridges run from north to south and occupy an area about eight miles wide. Beyond the beaches is the glacial moraine area, which is characterized by rolling prairie with scattered sharply rolling hills interspersed with lakes, ponds, marshes, and bogs. Elevations range from 880 feet above sea level where the Buffalo River enters the Red River near Georgetown to 1,475 feet in eastern Becker County.

Most of the land in the subbasin has been cleared for agriculture, although there are some large forest tracts in the eastern extremity, which reaches into the White Earth Indian Reservation. Surface water features include lakes, streams, ditches, creeks, and potholes. The lakes and potholes, which are located primarily in the upland morainal area, tend to store water for release at comparatively constant rates.

The dominant water feature in the subbasin is the Buffalo River, which begins in Tamarac Lake in Becker County and flows westerly to within about eight miles of Moorhead, where it is joined by its major tributary, the South Branch. From this point, it flows northwesterly to join the Red River about 12 miles north of Moorhead. The entire drainage area for the river and its tributaries is about 760,000 acres. However, particularly in the South Branch area, it is difficult to distinguish between the drainage boundaries of the Buffalo River Subbasin on the one hand and the Main Stem Subbasin on the other. Although the Buffalo River is the major stream,



Source: Gulf South Research Institute.

Figure I. BUFFALO RIVER SUBBASIN

most of the drainage from the beach ridges and flat plain is accomplished by the river's south branch and its numerous tributaries (Stony Creek, Whiskey Creek, Deerhorn Creek), which reach in a fingerlike pattern back into the steep upland ridges.

Within the flat valley plain, the stream slopes of the Buffalo River and South Branch average 1.4 feet per mile. The capacities of the channels are only sufficient to carry flood flows that have a chance of occurring every other year. The frequent overflow can be attributed to the mild gradients of the sinuous streams as they traverse the flat valley floor and the obstruction of flow by numerous fallen and standing trees within the channel banks.

III. PROBLEMS, NEEDS, AND DESIRES

III. PROBLEMS, NEEDS, AND DESIRES

The primary water-related problems, needs, and desires in the Red River Basin are flood control, fish and wildlife conservation and enhancement, recreation, water supply, water quality, erosion control, irrigation, wastewater management, and hydropower. Various water-related problems, needs, and desires have been identified for the Buffalo River Subbasin in previous planning reports on the basis of analysis of conditions and public and agency comments. The list of problems, needs, and desires for the subbasin is the same as the list for the Red River Basin as a whole, except for hydropower. Each problem is discussed separately below, with an emphasis on flooding problems.

Flooding Problems

Flooding along the lower reach of the Buffalo River and its south branch occurs on an average of once every two years. Most of the flooding is caused by spring snowmelt, but this can be intensified by rainfall. The major damages occur in the western part of the subbasin where high-value cropland is located. Although these floods do not result in high direct crop damage, they do force delays in planting operations, which results in reduced yields. Because of the short growing season, if water stays on the land too long, planting may be precluded altogether.

Besides spring snowmelt flooding, there is also a significant amount of flood damage from high-intensity rains during summer months. Although they do not occur very often, these summer floods are characterized by high peak flows. They also can cause extensive damage to maturing crops and make harvest operations difficult.

Two separate types of flooding occur: the most damaging type associated with river bank overflow (overbank flooding) and another type caused by runoff from snowmelt or heavy rainfall impounded by plugged culverts and ditches within sections of land bounded by roadways on earthen fill (overland flooding). In overland flooding, the trapped water slowly accumulates until it overflows the roadways and inundates section after section of land as it moves overland in the direction of the regional slope to reach river or stream channels.

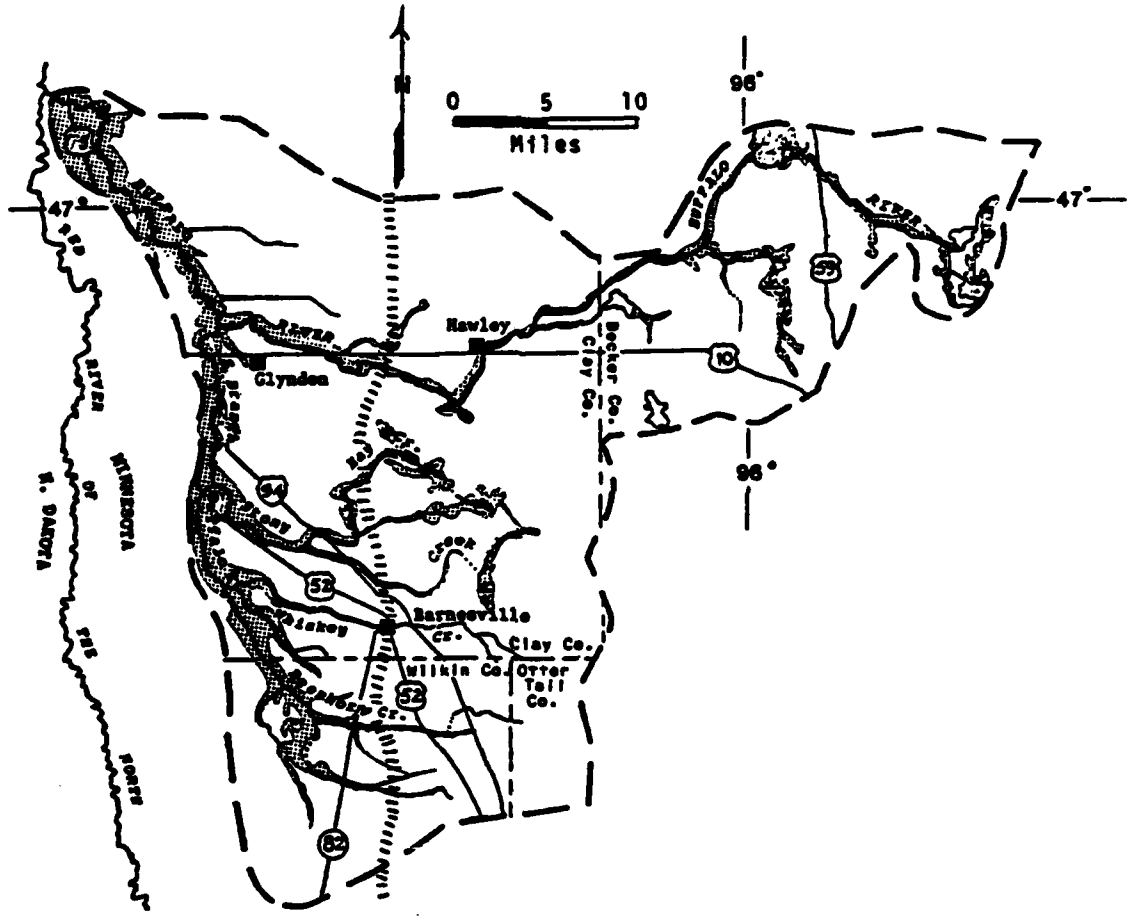
Topography contributes to flooding problems. Much of the frequent overflow can be attributed to mild gradients on the flat valley floor and to trees in stream channels that obstruct the flow of water. Because the South Branch with its tributaries drains a very large agricultural area, it is a major contributor to flooding along the lower Buffalo. Runoff from the beach ridge and uplands in the eastern part of the subbasin also contributes much of the floodwater and often coincides with that produced by the South Branch. To make matters worse, floodwater and surface drainage problems occur in the same areas. Damage is sustained by transportation facilities, farmsteads, and urban areas.

Localized flooding resulting from snow and ice accumulations and ice jams at points of constriction (like river bridges) is a frequent occurrence during periods of peak runoff. Flooding conditions within the subbasin are made even worse by peak flows along the Buffalo River that are often correlated with peak flows along the Red River, which cause subbasin waters to back up and to inundate large areas in the flat valley plain. Conversely, the subbasin contributes to floods on the main stem of the Red River. The subbasin contains about three percent of the total drainage area of the Red River, and runoff from the subbasin constitutes about 3.7 percent of the total Red River volume at the United States-Canada boundary.

Location and Extent

Figure II depicts the 100-year floodplain for the subbasin. In order to produce the delineation shown, a number of sources were investigated, including: (1) U.S. Geological Survey (USGS) Flood Prone Area Maps (Scale 1:24,000); (2) Federal Insurance Administration flood maps; (3) published secondary sources describing flooded areas; and (4) USGS 7½ minute topographic maps.

The map is a composite of available sources, supplemented where necessary by inferences. Because the sources were often incomplete and were based on surveys differing in detail and level of accuracy, it should be understood that Figure II constitutes a generalized delineation intended only for planning purposes. A more complete description of sources and methodology is given in Appendix A.



Source: Gulf South Research Institute.

Figure II. 100-YEAR FLOODPLAIN

According to this provisional delineation, the floodplain of the Buffalo River constitutes approximately 84,000 acres. Major components include: an 18,000-acre area on the Buffalo River in the eastern portion of the subbasin; a 22,000-acre area along the middle Buffalo course, from Manitoba Junction to the confluence with the South Branch; an 8,000-acre area from the latter point to the Red River; and a 36,000-acre area associated with South Branch and its tributaries.

The upper segment of the Buffalo River east of Manitoba Junction is characterized by numerous small round and linear lakes connected by linear wetlands and a narrow, well-defined floodplain. This is in strong contrast to the Big Bog area further north in the Red River Basin, where wetlands are more extensive and much less well defined. The configuration is mainly that of Federal Flood Insurance maps, with inferred data and spot checks against USGS topographic maps.

The area delineated as the middle Buffalo includes the river's course across the beach ridge area (centered near Hawley) and its entrance onto the flat valley plain. The former is marked by a well-defined floodplain and three small marsh areas. Width varies from a quarter mile near Manitoba Junction to well over half a mile at the confluence with South Branch.

From this point to the Red River, the Buffalo River floodplain widens to approximately one mile, bulges temporarily to three miles, and finally spreads out to become lost for want of topographic definition. In excess of 6,000 acres in this part of the floodplain are usually associated directly with overbank flooding from the Red River of the North.

As noted earlier in this section, the South Branch is a major contributor to floodwaters in the lower Buffalo River. Its delineation in Figure II bears this out in terms of extent of floodplain. Except for Stoney Creek, almost all of the 26,000-acre floodplain lies within the flat valley plain. The Stoney Creek floodplain comprises about 10,000 acres, the majority of which are associated with large, curvilinear marshlands in the beach ridge area in the central part of the subbasin.

Flood Damages

The primary areas affected by flooding throughout the subbasin's floodplain are urban, agricultural, and environmental in nature. Property

in the urban communities of Barnesville, Georgetown, Stockwood, and Hawley are vulnerable to infrequent large floods. Urban and rural damages are the only damage categories taken into consideration in the computation of average annual damages.

Present average annual damages in the subbasin are estimated at $1,498,000. This accounts for about four percent of the total average annual flood damages in the Red River of the North Basin. Average annual damages are divided into two classifications: urban and rural. Urban damages include damages to residences, businesses (commercial and industrial) and public facilities (streets, utilities, sewers, etc.). Rural damages include damages to crops, other agricultural assets (fences, machinery, farm buildings, etc.), and transportation facilities. Rural damages account for 99 percent of total average annual damages in the subbasin, and urban damages account for the remaining one percent.

Urban damages in the subbasin from the 1975 flood and average annual urban flood damages are displayed in Table 1. No urban flood damages were reported to have resulted from the 1979 flood. Urban damages sustained as a result of the 1975 flood far exceeded the average annual urban damages. Estimated residential damages from the 1975 flood amounted to $382,700, which greatly exceeded the average annual figure of $5,900. Business (commercial and industrial) damages from the 1975 flood were estimated at $306,700, compared to an average annual figure of $4,700. Flood damages to public facilities from the 1975 flood were estimated at $76,700, and average annual damages are estimated at $1,200. Total average annual urban flood damages are estimated at $6,500, and the 1975 flood event is estimated to have caused $766,100 in urban flood damages.

Average annual rural flood damages and rural flood damages incurred in the 1975 and 1979 flood events are shown in Table 2. Rural flood damages sustained in the 1975 flood event greatly exceeded both the 1979 and the average annual rural flood damage figures. In the 1975 flood event, rural flood damages included $17.4 million in crop damages, $16.6 million of other agricultural damages, and $449,000 in transportation damages. In comparison, the 1979 flood event resulted in $680,000 in crop damages, $245,000 in other agricultural damages, and $157,000 in transportation

Table 1

BUFFALO RIVER SUBBASIN, ESTIMATED 1975 AND AVERAGE ANNUAL URBAN FLOOD DAMAGES
(Thousands of 1979 Dollars)

Category	1975	Average Annual
Residential	$382,700	$ 3,300
Business	306,700	2,600
Public	76,700	700
Total	766,100	6,600

Sources: Red River of the North Basin Plan of Study, April 1977; Post Flood Report, 1975; Gulf South Research Institute.

Table 2

BUFFALO RIVER SUBBASIN, ESTIMATED 1975, 1979 AND AVERAGE ANNUAL RURAL FLOOD DAMAGES
(Thousands of 1979 Dollars)

	Year		
Category	1975	1979	Average Annual
Crop	$17,411.6	$ 680.0	$1,014.4
Other Agricultural	16,625.9	245.0	338.1
Transportation	449.1	157.0	139.3
TOTAL	34,486.6	1,082.0	1,491.8

Sources: Red River of the North Basin Plan of Study, April, 1977; Post Flood Reports, 1975 and 1979; Gulf South Research Institute.

damages. Total rural flood damages were $34.5 million in the 1975 flood and $1.1 million in the 1979 flood and are $1.5 million on an average annual basis.

Environmental Concerns

Conversion of native prairie, wetlands, and woodlands in the past (as well as the present regarding the first two habitat types) to cropland and pastureland has reduced the quality and quantity of terrestrial habitats for flora and fauna. Data supplied by the Minnesota Land Management Information Service indicate that 89 percent of the total acres in the subbasin are in cultivation and pasture or in open land uses. The Soil Conservation Service (1961) reported that a significant, but generally unrecognized, problem was damage to wetland habitat in the hilly and transition areas of the South of Hawley-South Buffalo Watershed from silt deposition in the majority of the remaining open waters and marshes. The U.S. Fish and Wildlife Service prepared a reconnaissance report of this watershed that indicated the need to establish land treatment measures to retard runoff and silt deposition in lakes and wetlands and the need to eliminate or rehabilitate ditches that would harm the wetlands of the hilly and transition zones (Soil Conservation Service, 1961). The Upper Mississippi River Basin Commission (1977) stated that land-related problems or issues pertained to drainage of wetlands, small lakes, and ponds to facilitate agricultural development; conversion of floodplains and environmental resources to agricultural and residential land uses; and damages to environmental resources from severe wind and water erosion.

Some of the aquatic resource problems such as sedimentation in the subbasin's lakes were discussed above. Other problems include low flows in some streams, pollution from point and nonpoint sources, periodic high fecal coliform levels, excessive turbidities, and fairly high to high nutrient levels in the Buffalo River. Most of these problems will be covered under Water Quality and Wastewater Management in the Problems and Needs or Existing Conditions sections. The U.S. Fish and Wildlife Service (1979) indicated that various types of pollution occurred commonly in the Buffalo River and South Branch and, to a lesser degree, in smaller

tributary streams. Clear waters are found in the upper reaches of the Buffalo, but the waters of the river are laden with silt and are very turbid in the reaches surrounded by farmlands. It was stated that these pollution problems prevent consideration of serious fish management, and that the shallowness of the streams, fallen trees, and debris-clogged channels hamper canoeing and boating activities.

Recreation Problems

There are abundant hunting opportunities within the subbasin; however, water-based recreational facilities have not been developed in the lake region. Shallow conditions and pollution from agricultural runoff, sedimentation, and excessive vegetative growth limit the recreational potential of the few lakes in the area for fishing, boating, and swimming.

The wetland areas that provide habitat for waterfowl, furbearers, and other animals are also subject to the effects of intensive agricultural practices. Seasonal dry cycles adversely affect wetland stability; however, more permanent lakes nearby in the Ottertail River Subbasin provide wildlife habitat during dry periods.

Water Quality Problems

Water quality problems in the subbasin, which were described by the Upper Mississippi River Basin Commission (1977), include the following: (1) inadequate streamflows in late summer, fall, and winter months to assimilate wastes and meet minimum streamflow requirements for recreational and environmental uses; and (2) pollution from municipal and agricultural wastes. The subbasin lies within a segment that has been classified as Water Quality Limited because periodically the streamflows are not sufficient to provide enough dilution to maintain water quality standards after introduction of secondarily (or best practicably) treated effluents and because nonpoint sources are expected to cause violations of water quality standards (Minnesota Pollution Control Agency, 1975). Major water quality problems identified by the agency, exclusive of wastewater-related problems that will be discussed in a later part of this section, are turbidity and periodic low dissolved oxygen levels. Comparison of Buffalo River quality data with streams in the area revealed that turbidity

problems are probably caused by natural processes or agricultural activities. Sediment sources within the counties of the subbasin are upland erosion--low to medium low, streambank erosion--low to medium low, drainage ditch erosion--low to medium, and the presence of gully and wind erosion (Minnesota Pollution Control Agency, 1979). No source of the dissolved oxygen problem was given by the agency. It was further mentioned that phosphorus levels were fairly high.

The Soil Conservation Service (1961) indicated that wind and water were eroding and transporting soils into natural channels, road ditches, and constructed ditches in the South of Hawley-South Buffalo Watershed. The results of this erosion were a reduction in capacity of drainage channels or ditches in the western three-fifths of the watershed and deposition of silt in natural open-water wetlands in the hilly and transition zones of the watershed. Erosion and sediment damages from floodplain scour, streambank erosion, infertile overwash, etc., were deemed insignificant. The Minnesota Water Resources Board (1979), in their overall plan for the Buffalo-Red River Watershed, reported that wind and water erosion of soils had caused maintenance problems in drainage systems through sediment deposition. These erosion activities are evidently contributing to turbidity violations in the area's streams, as was stated by the Minnesota Pollution Control Agency (1975). The Board indicated further that pollution problems may occur from seepage of septic tanks and drainfields, animal wastes and barnyards, and runoff from chemically fertilized cropland and from use of chemicals for weed and insect control.

Groundwater quality problems are related to high concentrations of iron and manganese, dissolved solids, and sulfate (Upper Mississippi River Basin Commission, 1977; Minnesota Water Resources Board, 1979; Maclay et al., 1969).

Water Supply Problems

The total area of available surface water in lakes in the subbasin is approximately 918 acres. Since only about half of these lakes are over 40 acres in size, most would be unable to meet water supply needs (because of inadequate storage potentials). Communities in the subbasin

use groundwater for all municipal needs. Local public officials in two of the largest towns in the subbasin reported no water supply problems. Barnesville, the largest town, reported water shortages during the warm months of August and September when consumption is high and aquifer replenishment is low. The town is planning additional wells and a water main looping system for greater pressure reliability. The water is very hard in all areas of the subbasin, and iron and rust removal is usually required.

Erosion Problems

Soil erosion in the subbasin presents a definite problem that must be closely watched. About 80 percent of the area is flat, with slopes of three percent or less. The remaining area has slopes of five to 10 percent. Although gully erosion is not prevalent and is confined largely to rilling, sheet erosion is moderate to severe and, if not checked, will cause much of the steeper land to be retired from crop production because of topsoil loss. Except for areas where conservation is practiced, soil drifting is a severe problem even on heavy soils. Wind erosion has caused most of the flat portion of the watershed to lose up to one-third of its topsoil, and limited areas have lost as much as one-half of their topsoil.

Wind and water erosion is moving soil into road ditches, natural channels, and constructed ditches, which results in reduced channel capacities and high maintenance costs to facilities in the western three-fifths of the area. Damages are occurring to wetland and open water habitats in the hilly and transition zones through silt deposition.

Irrigation

Irrigation practices are increasing in the subbasin to provide more efficient crop production. Even when normal amounts of rainfall occur, much can be lost through runoff or deep percolation. The amount of runoff is more significant in the northeastern portion of the subbasin and is greatest during the spring when the snow cover begins to melt. Large amounts of groundwater are necessary to support agricultural irrigation and industrial needs. Groundwater is more available in the eastern part of the subbasin, primarily in Becker and Ottertail counties. Irrigated

acreage in these two counties increased by the same percentage (244 percent) between 1970 and 1974. Becker County increased from 275 acres to 945 acres, and Ottertail County increased from 4,328 acres to 14,852 acres.

Although there is a lack of large amounts of groundwater in the western part of the subbasin, irrigation practices are expected to continue to increase. Many farmers will invest in an irrigation system to reduce the climatic risk involved in agriculture.

Wastewater Management

The Minnesota Pollution Control Agency (1975) reported that the microbiological quality of the Buffalo River near its mouth at Highway 75 was unacceptable. Possible sources of the problem were inadequately treated sewage entering the river and livestock wastes; data from the monitoring station at this location indicated that a large part of the violation could be attributed to nonpoint sources.

Table 3 gives the point source discharges in the subbasin and their respective problems and treatment needs. Of the 10 municipalities, Audubon, Hawley, Glyndon, Barnesville, and Hitterdal have adequate wastewater treatment plants. Those with treatment needs include Callaway, Lake Park, Sabin, and Georgetown. Callaway and Lake Park have inadequate facilities that may have to be replaced; Sabin's facility may be adequate if the oxidation pond leakage is corrected. Georgetown's problems are associated with malfunctioning septic tanks, which can be rectified with a collection and treatment system. Of the two industrial sources, Kost Brothers posed the only problem. It is assumed that violations occur to water quality standards downstream from those point sources identified as having inadequate treatment (Minnesota Pollution Control Agency, 1975).

Hydropower

There are no hydropower plants in the subbasin. The National Hydropower Study did indicate a potential for development in portions of the subbasin. Most of the future hydropower developments in Minnesota, however, are expected to occur to the southeast of the Red River Basin, particularly in the Minneapolis-St. Paul area.

Table 3

PROBLEMS AND TREATMENT NEEDS OF POINT SOURCE DISCHARGERS IN THE BUFFALO RIVER SUBBASIN

Receiving Water	Discharger Description	Discussion of Problems	Treatment Needs	Other Planning Considerations
Red River of the North	Oakport Township	Inadequate treatment	See narrative	Connection to Fargo proposed; if build own plant, NPDES application required 180 days prior to discharge
Buffalo River via a county ditch	Callaway	Inadequate treatment, overloaded system	Need new facility	Low on MNL draft permit
Buffalo River via a county ditch	Audubon	Satisfactory system	Removal needed; better disinfection needed	
An unnamed slough	Lake Park WTW	No treatment	Treat wastes or connect to municipal system	Contract for connection option executed 4/1/75; connection by 9/1/76
Buffalo River via Stinking Lake	Lake Park	Treatment won't meet final effluent standards	New facility	Interim standards apply until 12/31/76
Buffalo River	Hawley	No apparent problems	May need new facilities in future when population increases	Not on MNL
Buffalo River	Kost Brothers, Inc.	Nature of problems not known	Not known	Have planned holding cells which will eliminate discharge
Buffalo River	Ames Sand and Gravel	Nature of problems not known	Are currently required to be in compliance with standards	
Buffalo River via a ditch	Glyndon	Limited reporting, poor maintenance	Will need a new facility when population increases	Low on MNL
Whiskey Creek	Barnesville	No apparent problem	Improved operation of ponds	When population increases plant may become inadequate
Absorption ponds	Sabin	Ponds leak, may be undersized	Correct leakage of ponds and expand their size	When problems are corrected, no discharge to surface waters will occur; no permit required
Buffalo River via a ditch and a slough	Hitterdal	No apparent problems	None expected	Population is projected to decline-facility should be adequate
Buffalo River	Georgetown	No treatment	New facility	Low on MNL-apply for permit 180 days before any discharge

Source: Minnesota Pollution Control Agency, 1975.

Public Perception of Problems and Solutions

The public's perception of problems and solutions in the subbasin appear adequately defined although the last Corps of Engineers public meeting in this area was in 1971. The subbasin is also organized into a single watershed district. The Buffalo-Red River Watershed District is an outgrowth and expansion of the South Buffalo Watershed District. The District's Overall Plan, published in 1979, contains specific information regarding the public's perception of problems and solutions.

The documents stated that the major concerns of the local people are the alleviation of flooding and improvement of surface drainage outlets, especially in the western part of the subbasin. Other expressed concerns deal with fish and wildlife conservation, increased irrigation, and erosion control. The Work Plan formulated a water management plan that included floodwater retarding structures, wildlife measures, channel improvements, and land treatment measures.

In 1959, the Board of Commissioners of Wilkin, Clay, and Ottertail counties and the Wilkin, Clay County, and West Ottertail Soil Conservation Districts submitted an application for planning assistance to the Soil Conservation Service. The application cited extensive damage to farm lands, urban areas, and public facilities from floods; soil erosion problems caused by wind and water; drainage, irrigation, and water supply needs; and measures needed to reduce soil alkalinity and enhance fish and wildlife. Proposed solutions to the problems included flood control structures with environmental components, land treatment on 11,000 acres, drainage ditches, and retention structures to impound water for municipal and agricultural use.

Although no major flood damage reduction projects have resulted, several alternatives remain viable. The 317 miles of channels constructed by local residents over the years are tangible evidence of public concern for flooding and drainage problems in the subbasin.

Additional evidence for interest in flood control measures is contained in public hearings held in East Grand Forks in 1978 and 1979 before subcommittees of the Committee on Public Works and Transportation of the U.S. House

of Representatives. From these documents, it is evident that residents of the Red River Basin consider flood control to be the primary water related need for the area and that they are interested in whatever solutions may be proposed by Federal, state, or local agencies.

IV. DESCRIPTION OF SUBBASIN RESOURCES

IV. DESCRIPTION OF SUBBASIN RESOURCES

This section discusses the primary resource conditions within the subbasin that are water-related and that would be affected by a comprehensive water and related land resources plan that centers on flood control measures.

Social Characteristics

The population of the subbasin has remained fairly stable over the past 50 years, with only slight increases each decade through 1970. Between 1970 and 1977, the population increased by 15.3 percent, reaching a figure of 17,694 in 1977. This makes the subbasin the fastest growing of all subbasins of the Red River of the North Basin. The growth occurred primarily in the counties of Becker, Clay, and Ottertail. In Becker and Ottertail, growth was attributable to moderately high inmigration (8.9 percent and 6.4 percent, respectively). Wilkin County had a population decrease and an outmigration rate of 7.3 percent. Clay County's growth was largely attributable to expansion of the Fargo-Moorhead SMSA.

The three largest towns in the subbasin are Barnesville (1,989), Hawley (1,682), and Glyndon (924). Between 1970 and 1977, Hawley and Glyndon increased by 23 and 37 percent, respectively. The increase occurred primarily because the two towns are situated on the main route between Fargo-Moorhead and the Detroit Lakes recreation area.

The population density for the subbasin increased from 12.9 persons per square mile in 1970 to 14.9 persons per square mile in 1977.

Communitites within the subbasin are mainly agricultural service centers and, based on the following indicators, are expected to exhibit a strong cohesiveness: (1) home ownership; (2) length of occupancy and place of residence, (3) place of work; and (4) ethnic homogeneity.

Portions of four counties are in the subbasin, including Clay, Becker, Wilkin, and Ottertail. According to Census data (1970), home ownership varies from 68.1 percent in Clay County to 81.8 percent in Ottertail County. The percentage of persons living in the same home as in 1965 ranged from 48 percent in Clay County to 58 percent in Wilkin County, increasing to 68 percent and 85 percent, respectively, for those living within the same county. It should be noted that the population centers for the subbasin

are located in Clay County, which ranks second lowest in the entire Red River Basin for length of occupancy and place of residence indicators. Only two counties in the North Dakota portion of the Basin register lower home ownership figures. The inclusion of Moorhead in the Clay County statistics accounts for the low figures with respect to indicators and does not reflect the agricultural nature of the towns within the subbasin.

Many people in Clay County commute to the larger urban centers outside the subbasin. These urban centers include Detroit Lakes, Fergus Falls, and the Fargo-Moorhead area. Only 60.5 percent of the people in Clay County reside and work within the county. In contrast, Census data show a significantly higher ratio of people living and working in the same county for the other three counties in the subbasin (82.7 percent in Becker, 75.8 percent in Wilkin, and 84.6 percent in Ottertail). There is also a sizable seasonal migration of sugar beet field workers.

The population is primarily of Norwegian descent. The minority population is too small to be identified; however, there are approximately 3,400 American Indians residing on the White Earth Reservation, a portion of which is located within the subbasin boundary.

The formation of the South Buffalo Watershed District, which was later expanded to become the Buffalo-Red River Watershed District, illustrates a public interest in water resource management programs and contributes to a sense of unity for residents of the subbasin.

Economic Characteristics

Employment

During the last decade, farm employment in the subbasin decreased by more than 18 percent. The number of farms in the area has been decreasing, and the acreage per farm has steadily increased in a move toward large-scale farming. Mechanization is replacing manpower on the farm. Fortunately, employment in other sectors has increased significantly; as a result, total employment increased from 5,834 in 1970 to 7,962 in 1977, which represents a 36 percent increase.

The agricultural sector has been, and will continue to be, the largest employment sector, followed by services and trade. Manufacturing employment in the subbasin is insignificant.

Unemployment in the subbasin has stabilized at approximately five percent during the 1970's. Employment is high during the spring and summer because of agricultural activities and again during the fall because of harvesting and processing. All agricultural activities decrease in the winter.

Income

Total personal income for the subbasin increased from $84 million to $122 million between 1960 and 1977 (as expressed in 1979 dollars). The major portion of the subbasin is in Clay County, where farm income accounts for more than 25 percent of the total personal income. Cash grain sales amount to 62 percent of the farm income. Average per capita income during the same years increased from $5,468 to $6,892, which was significantly lower than the 1979 average income figure of $8,314 for the entire state. Although there has been an upward trend in both total personal and per capita incomes, fluctuating farm prices are the primary determinants of income changes from year to year. Also, severe flooding can cause sharp declines in income, as happened in 1975.

Business and Industrial Activity

Agriculture

Agriculture and its related economic activities are the primary influence on the subbasin's economy. The production of small grains is the most important agricultural component. Approximately 77 percent (or 585,939 acres) of the subbasin's land area is under cultivation, and another 12 percent is devoted to pasture. The farms in the western portion of the subbasin tend to be very large and to concentrate on cash crops rather than on livestock production. The farms farther east, however, are smaller, and livestock and livestock products are more important.

The major crops grown in the subbasin are identified in Table 4. Wheat is the leading crop, accounting for about 34 percent of the harvested acreage. This is followed by barley (18 percent), sunflowers (14 percent), and hay, sugarbeets, corn, oats, and soybeans (33 percent, collectively, of the harvested acreage). There are also minor acreages of potatoes, flax, and rye. Of particular significance is the emergence within the past few years of sunflowers as a major crop within the subbasin.

Table 4

1978 CROP STATISTICS, BUFFALO RIVER SUBBASIN

Crop	Harvested Acres	Yield Per Acre	Total Production
Wheat	152,300	33.5 bushels	5,102,050
Barley	80,230	49.4 bushels	3,963,362
Sunflowers	63,880	1,550 pounds	99,014,000
Hay	36,100	2.3 tons	83,030
Sugarbeets	34,086	25,800 pounds	879,418,800

Source: Gulf South Research Institute.

Manufacturing

Most of the manufacturing establishments in the subbasin are farm-related industries. There are six industries that produce livestock feed and various types of fertilizer. One establishment manufactures farm equipment. In addition to these industries, there are four newspaper or printing establishments, a concrete and gravel company, a bee farm, and a plant that produces tortillas. The majority of these manufacturers are located in the towns of Barnesville and Hawley, which are the largest towns in the subbasin. More than 50 percent of the companies were established before 1950. Table 5 groups the manufacturers according to their Standard Industrial Code (SIC) numbers.

Table 5

MANUFACTURING ESTABLISHMENTS, BUFFALO RIVER SUBBASIN

SIC	Description	Estimated Employment
20	Food and Kindred Products	80
27	Printing and Publishing	30
28	Chemicals and Allied Products	15
32	Stone, Clay and Glass Products	15
35	Machinery	35
	TOTAL	175

Source: 1979-80 Minnesota Directory of Manufacturers.

Trade

In 1977, total trade receipts for the subbasin exceeded $122 million (expressed in 1979 dollars). Nearly 53 percent (or $63.9 million) of the receipts were wholesale trade. Retail trade and selected service receipts were $58.5 million and $6.4 million, respectively, in 1977.

Transportation Network

Efficient transportation is vital to the economic well-being of the subbasin. Because the area is primarily rural, a good transportation network to move farm products to market and services from the metropolitan areas is essential. The system of county, state, and Federal highways is the major means for the transportation of individuals and goods in the subbasin. The main north-to-south routes include State Highways 9 (near Glyndon) and 32 (through Hitterdal) and Federal Highway 59, which runs the entire length of the state of Minnesota, north to Canada, and south to the state of Iowa and it intersects with several east-west highways that travel to the urban areas of Minneapolis-St. Paul, Duluth, Fargo-Moorhead, and Grand Forks, North Dakota. Federal Highway 10 travels in an east-to-west direction from the Fargo-Moorhead area through the subbasin towns of Glyndon, Hawley, Lake Park, and Audubon. This route connects to State Highway 210 approximately 60 miles east of Audubon, and the highway crosses the state to the Port of Duluth. State Highways 9 and 34, which intersect at Barnesville, connect with Interstate 94, which runs through the extreme southwest portion of the subbasin and provides a connection to the major urban areas east and west of the subbasin.

The subbasin is also traversed by two rail lines that parallel the major Federal and state highways. The Burlington Northern Railroad passes through Barnesville, Glyndon, Hitterdal, Lake Park, and Audubon; the Soo Line runs through Calloway. Both of these lines travel to Duluth and to the Minnesota-St. Paul area. Because of limited rail service and freight car shortages, however, commercial trucking has been steadily increasing in the subbasin. Rather than depend on the trains, some of the larger farms operate their own truck fleets.

Two pipelines cross the subbasin in a northwest-to-southeast direction. A petroleum product pipeline passes near Barnesville, and a natural gas pipeline passes between Hawley and Hitterdal.

There is only one airport located within the subbasin. The airport is in Hawley, and it is capable of accommodating all single engine, most twin engine, and some light jet aircraft.

Land Use

Approximately 77 percent of the subbasin is under cultivation, 11.7 percent is pasture and open land, 6.2 percent is in forest, almost 4 percent is water and marsh, and 0.7 percent is urban. Much of the cropland is located in the western part of the subbasin, which was once prairie land with tall grasses and shrubs. The native grasses and shrubs have been reduced by extensive cultivation to small scattered areas and along stream banks. The trees are limited to the floodplain. The middle of the subbasin is an area rich in sand and gravel deposits, many of which are being worked. The western area also includes some wildlife areas and extensive areas of shrub oak and oak forests. The eastern part of the subbasin is extensively cropped, and there are areas of forest and wildlife also.

Environmental Characteristics

Climate

Climatological data can be obtained from the U.S. Weather Bureau stations in Moorhead, Georgetown, and Hawley. The subbasin has a continental climate characterized by cool weather and reduced amounts of precipitation. The area's mean monthly temperature is 58°F in the summer and 24°F in the winter. There is an average frost-free period of 130 days from the middle of May to the end of September. The average annual snowfall is 30 to 40 inches. Annual precipitation, including snowfall, averages 20 inches in the west and increases to about 24 inches in the eastern section. Approximately 70 percent of the annual precipitation occurs during the growing season from April to September.

Geology

The subbasin lies within the Central Lowlands Province of the Interior Plains Division. The subsurface geology consists of Pre-Cambrian undifferentiated igneous and metamorphic rock underlying the entire subbasin. In the northwest and southwest sections, small areas of cretaceous Dakota shells and sandstones overlie bedrock. Glacial drift, ranging from 100 to 300 feet in thickness, overlies Pre-Cambrian and cretaceous deposits. The western section of drift underlies Lake Agassiz silts and clays that range in depth from 20 to 80 feet. Exposed glacial drift in the central portion consists of a bank of lakeshore sand and gravel deposits and beach ridges trending north to south, forming the transitional zone between the flat western area and the hilly eastern morainal region which is characterized by deposits of glacial till. Almost half of the subbasin is overlain by till composed of clay, sand, silt, and gravel. Marshes, lakes, and peat bay areas are found within the morainal region of the subbasin.

Biology

The major forest types found in the subbasin include the elm-ash-cottonwood, myrtle-basswood, and aspen-birch communities. The elm-ash-cottonwood type is found along the Buffalo River, South Branch of the Buffalo, and smaller tributaries in the floodplain, with greatest development between Kragnes and Hawley on the Buffalo and between Dilworth and Sabin along the South Branch. Typical plants include American elm, green ash, cottonwood, hackberry, boxelder, silver maple, and hawthorn. The maple-basswood community reaches its best development in western Clay County northeast of Rollag and in the headwaters region in Becker County; the aspen-birch type is also most abundant in the headwaters area. Common plants consist of sugar maple, red maple, basswood, and yellow birch in the maple basswood type and aspen, paper birch, snowberry, and red-osier dogwood in the aspen-birch type (North Central Forest Experiment Station and Minnesota State Planning Agency, no date; U.S. Fish and Wildlife Service, 1980; Wanek, 1967).

The Minnesota Water Resources Board (1979) provided some description of the vegetation of the subbasin. The Board reported that the native prairie, comprised of tall prairie grasses and shrubs, has been substantially

reduced by cultivation and is now confined to small, scattered areas and stream banks. Trees are also limited to floodplains in the western portion in the glacial Lake Agassiz bed. In the transition areas between the lake plain and the morainal area, beach ridges occur along with an abundance of county, state, and Federal wildlife areas. In those areas not cleared for agriculture, some prairie occurs intermixed with stunted shruboak and scattered oak forests; common associates with bur oak include aspen, boxelder, and ash. The prairie in the morainal area has also been extensively cultivated, with natural vegetation presently composed of intermittent stands of mixed pine hardwoods. These forests become more dominant in the extreme eastern part of the subbasin, where white and red pine occur in the well-drained, medium textured soils, and jack or red pine are on the coarser soils.

The Red River Lake Plain, Glacial Lake Agassiz Beachlines, and Border-Transition are the principal wetland zones of the subbasin. The Lake Plain zone occurs in the Red River floodplain area in the western part of the subbasin in Clay and Wilkin counties. As mentioned earlier, agricultural lands now dominate this area where shallow wetlands and native prairie once abounded. The Glacial Beachline zone extends through the middle of the subbasin in Clay and Wilkin counties; this area once contained numerous shallow wetlands. The Border-Transition zone comprises the remainder of the subbasin in the eastern portion and includes five major wetland types: Type 3--Shallow fresh marshes; Type 4--deep fresh marshes, Type 5--open fresh marshes; Type 6--shrub swamps; and Type 7--timbered swamps. Wetlands within the Border-Transition zone have received first and third priority rankings for preservation in the subbasin (Mann, 1977; U.S. Fish and Wildlife Service, 1980).

Wildlife habitats of importance in the subbasin consist of the remaining prairie, wetlands, and woodlands. Although a very limited amount of native grasslands still occur, they are valuable habitats for plants and animals, including a Federally proposed endangered butterfly (Dakota Skipper) and the rare greater prairie chicken (primarily glacial beachline areas). The wetlands of the subbasin provide excellent habitats for both aquatic and terrestrial biota. Wetlands afford cover, nutrients,

and breeding and spawning areas for both vertebrates and invertebrates. When adjacent to upland areas, essential habitats for breeding, feeding, and resting are provided for waterfowl, big and small game, furbearers, and a variety of other wildlife such as songbirds. Woodlands and brushy areas also furnish important feeding, resting, breeding, and nesting habitats for wildlife, as well as a travel corridor in the western portions of the subbasin where extensive farming occurs. The forested areas are suited to a greater variety of wildlife than any other major habitat type in the subbasin (U.S. Fish and Wildlife Service, 1980).

The principal big-game animal in the subbasin is the white-tailed deer. In 1978, the following harvest figures from firearm and archery hunting were given for each county included by the subbasin limits: Becker--917, Clay--284, Ottertail--1,708, and Wilkin--91. Some black bear may inhabit the extreme eastern portion; Becker County had a total of 12 harvested in the 1978 season. Common small game mammals consist of the gray squirrel in the wooded, eastern part; cottontail in the southern portion; and jackrabbit in the western zone. Although the pheasant (<5/100 miles) and ruffed grouse are limited in numbers when compared to other regions in the state, they are the principal upland game birds in the region. Typical furbearers are the beaver, muskrat, mink, and raccoon. Waterfowl production is important in the potholes and shallow marshes, with mallards and blue-winged teal most common in the potholes and goldeneye and woodduck most common in the eastern woodlands. One hundred and three species of breeding birds have been identified in the region (Region 1S) included by the subbasin: non-native pest birds--three species; non-native game birds--83 species. Common nongame breeding birds are the mourning dove, horned lark, yellowthroat, common grackle, and red-winged blackbird. Seventeen species of amphibians and reptiles have been reported from the counties encompassed by the subbasin, with the more common herpetofauna consisting of the northern prairie skink, western plains garter snake, western chorus frog, and the northern leopard frog. A total of 31 nongame mammals have been indicated from the counties of the subbasin and consist of species such as the short-tailed shrew, coyote, striped skunk, eastern chipmunk, deer mouse, and meadow vole (literature

cited in Mann, 1979; Henderson 1978 a and b, 1979; Henderson and Reitter, 1979; U.S. Fish and Wildlife Service, 1980).

The North Branch of the Buffalo River originates at Lake Tamarac in Becker County and flows through a series of morainic hills and beach ridges. Because of these hills and ridges, the velocity of the flow on the North Branch is increased; however, the flow usually remains constant because of the release of water from the numerous lakes in the area. The South Branch and its tributaries are located within the Glacial Lake Agassiz plain and are characterized by small channels with a minimal slope. These streams receive less influence from lakes and, consequently, their flow rates fluctuate seasonally (U.S. Fish and Wildlife Service, 1979: Minnesota Water Resources Board, 1979).

All of the streams in the subbasin, with the exception of Loundale Creek, have been classified by the Minnesota Department of Natural Resources as a rough fish, forage fish (Class IV) stream. Streams are designated as a Class IV stream when the fish populations within the stream are dominated by rough or forage fish such as carp, minnows, and suckers. Few game fish are present in a Class IV stream. Loundale Creek, located in Wilkin County, is classified as a Class I (trout) stream. Although Loundale Creek has a fair amount of trout habitat, it is managed for "put and take trout fishing" (U.S. Fish and Wildlife Service, 1979).

Rough fishes common to branches of the Buffalo River include the white sucker, golden and northern redhorse, carp, common shiner, fathead minnow, Johnny darter, and hornyhead chub. As mentioned above, few game fishes frequent the Buffalo River except during early spring when spawning occurs. However, game fish such as northern pike, walleye, largemouth bass, channel catfish, and black crappie do inhabit the numerous lakes along the North Branch (Minnesota Water Resources Board, 1979; U.S. Fish and Wildlife Service, 1979). Table 6 lists the occurrence of the fish species in the lakes of the subbasin.

Cvancara (1970) conducted an inventory of the mussels that inhabit the Red River of the North and 18 of its tributaries. The live mussels discovered in the Buffalo River during this study included Fusconaia flava, Lasmigona complanata, Anodonta grandis, Anodontoides ferussacianus,

Table 6

OCCURRENCE OF FISH SPECIES IN THE LAKES WITHIN THE BUFFALO RIVER SUBBASIN

Lakes	Northern Pike	Walleye	Largemouth Bass	Channel Catfish	Yellow Bullhead	Brown Bullhead	Black Bullhead	Carp	Northern Redhorse	White Sucker	Tullibee	Rock Bass	Black Crappie	Hybrid Sunfish	Bluegill	Pumpkinseed	Green Sunfish	Yellow Perch
Axberg					X												X	
Barnes, North							X			X				X		X	X	
Birch						X												
Boyer		X				X							X		X	X	X	X
Buffalo	X	X	X			X				X	X	X	X		X	X		X
Canary		X				X	X							X	X		X	X
Eagen			X											X	X			
Fifteen	X	X								X				X	X	X	X	X
Fish	X				X	X	X						X	X	X	X		
Forget-Me-Not							X			X							X	X
Gourd							X			X							X	X
LaBelle, East							X			X			X		X			X
LaBelle, West	X		X				X			X					X			
Lee	X								X	X			X	X	X	X	X	
Lime							X											
Long							X											
Momb	X				X	X	X			X					X			X
Olaf, West	X	X	X			X			X	X			X	X	X	X		X
Perch					X	X	X		X	X					X		X	X
Rice	X	X	X		X	X	X			X			X		X	X		X
Rock	X	X	X		X	X	X			X			X		X	X		X
St. Clair	X					X	X			X					X			X
Sand	X	X	X				X			X				X	X		X	
Silver	X	X	X	X		X		X	X	X		X	X		X	X		X
Spring										X						X		
Stakke	X		X				X			X				X	X	X	X	X
Stinking	X	X				X	X	X		X						X		X
Sugar Bush, Big	X	X	X		X	X	X		X	X					X	X		X
Sugar Bush, Little	X		X		X	X	X			X				X	X	X		X
Talac	X		X				X			X				X	X	X	X	
Tamarac	X				X	X	X			X								X
Ten	X																	
Turtle	X	X	X			X				X			X	X	X	X	X	X
Wheeler					X					X								
Yort										X							X	
Unnamed	X				X	X	X								X	X		X

Source: A Biological Survey of the Buffalo River Watershed, Minnesota Department of Conservation. Special Pub. 44, 1967, as stated in the Overall Plan, Buffalo-Red River Watershed District, Minnesota Water Resources Board, January, 1979.

and Lampsilis siliquoidea. Two other species, Amblema costata and Strophitus rugosus, were represented only by empty shells (U.S. Fish and Wildlife Service, 1979).

Table 7 describes the fish and game lake resources, by lake type, of the counties comprising the subbasin. Emphasis should be placed on Clay County, because it encompasses most of the watershed area.

Water Supply

Adequate supplies of groundwater for rural and domestic purposes are available throughout the watershed. Domestic water supplies are available from sand lenses in glacial till underlying the lake sediments, although test drilling is necessary to locate sand and gravel lenses capable of yielding large quantities of water. Wells in the eastern portion may be drilled as deep as 200 feet before reaching an adequate water supply. The recharge for these wells is in the lateral moranic area in the eastern portion of the watershed. Water for irrigation of crops is obtained largely from surface water supplies. The total area of lakes in the watershed area is 918 acres.

Communities in the subbasin obtain their water supplies from groundwater. Annual usage for Hawley and Glyndon is 50,000,000 and 43,800,000 gallons, respectively. Barnesvilles' increasing population has caused its water usage to increase to an estimated 127,750,000 gallons per year. New wells and a water main looping project are being planned for the city because of its population increase and, also, because its wells tend to go dry during the late summer and fall.

Ground and surface water quality is suitable for most purposes. The water quality is hard to very hard and the groundwater is moderately mineralized. In most cases, only rust removal treatments and chlorine and flouride additives are used.

Water Quality

Water uses in the streams of the subbasin include industrial, agriculture and wildlife, fisheries and recreation, and other uses (Minnesota Pollution Control Agency, 1975). Major water quality problems, as described in the Problems and Needs discussion, include violations with fecal coliforms, turbidity, and dissolved oxygen. Five of the 10 municipal point sources have treatment needs for their wastewater facilities, as does one of the two industrial dischargers.

Table 7

FISH AND GAME LAKE RESOURCES, BY LAKE TYPE, IN THE COUNTIES INCLUDED IN THE BUFFALO RIVER SUBBASIN

	County							
	Clay		Wilkin		Becker		Ottertail	
Type	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Dry Lake Basins[1]	2	68	0	0	32	2,379	27	1,110
Game Lakes[2]	57	1,930	24	523	249	20,709	605	31,184
Marginal Lakes[3]	36	2,026	-0-	-0-	263	25,669	267	26,633
Fish and Game Lakes[4]	-0-	-0-	-0-	-0-	-0-	-0-	4	515
Fish Lakes[5]	4	--	1	--	113	--	131	--
Unclassified Lakes[6]	1	38	1	150	48	6,019	72	28,110
Centrarchid Lakes[7]	3	399	-0-	-0-	22	13,013	20	12,695
Walleye Lakes[8]	-0-	-0-	-0-	-0-	13	13,056	13	72,140
Trout Lakes[9]	-0-	-0-	-0-	-0-	2	57	1	31

[1]Dry lakes as reported here included those basins that do have standing water throughout the year. This includes drained lake basins, dry basins with emergent vegetation such as cattails, and shrub swamps.

[2]Game lakes are those lakes shallower than six feet that ordinarily contain water throughout the years. They are ordinarily designated as being Type III or Type IV marshes.

[3]Marginal lakes are those that range from six to 20 feet deep, winterkill, and frequently have rough fish populations. Lakes with inlets are most likely to have rough fish populations.

[4]Fish and game lakes are defined as lakes in which both the game and fish resources are of major importance. These are lakes with several distinct connected basins, some river lakes, impoundments (especially the navigation pools on the Mississippi River), and the northern pike--wild rice--waterfowl lakes.

[5]Fish lakes are those that do not winterkill and have maximum depths that are ordinarily more than 20 feet and average depths that are 10 feet or more. Some soft water lakes, however, have average depths less than 10 feet and do not winterkill, and some fertile shallow lakes have inflows of water that add sufficient oxygen to prevent winterkills.

[6]Unclassified fish lakes are those where sufficient information is available to determine that they do not winterkill and are definitely fish lakes, but data available do not justify further classification. This category also includes a few lakes that do not readily fall into the remaining categories. For example, rough fish lakes that do not winterkill.

[7]Centrarchid lakes are those having fish populations that are primarily composed of bluegills, pumpkinseed, crappies, rock bass, largemouth bass, and/or smallmouth bass. These lakes frequently have good populations of northern pike. Some of these lakes contain populations of walleye that are either artificially maintained or are a natural population that is a small fraction of the total fish population. In the northeastern part of the state, smallmouth bass and rock bass tend to be the most important segments of a centrarchid population in a lake. Crappies and green sunfish are the centrarchids that occur most commonly in very eutrophic southern lakes.

[8]Walleye lakes are those having walleyes, yellow perch, common suckers, northern pike, and frequently tullibee as the main constituents of the fish population. Sometimes these lakes have fair sized populations of centrarchids, but they tend to be restricted to protected areas such as shallower, weedy bays.

[9]Trout lakes are those containing known populations of trout, either naturally or by stocking.

Source: Peterson, 1971.

Table 8 shows water quality data for the Buffalo River near the mouth at U.S. 75. The data represent 30 reports from 1971-74. Violations for the dissolved oxygen parameter occurred in seven percent of the samples; ammonia in three percent; fecal coliform in 30 percent; and turbidity in 37 percent. Fairly high levels of phosphorus were reported also. Suspected sources for these violations were described in the Problems and Needs section.

Table 9 presents more recent quality information for the Buffalo River at Hawley and near Dilworth and for the South Branch of the Buffalo River near Sabin. Two sampling periods are represented: October 1977 (low flow) and April 1978 (high flow). Hardness exceeded the 500 mg/1 criterion for industrial use at both Sabin and Dilworth during low flow, as did dissolved solids for agriculture and wildlife use (700 mg/1) at Sabin during this same period. During high flows, nutrient levels (total nitrogen and phosphorus) were elevated at all three stations, and iron exceeded the EPA (1976) criterion of 1,000 ug/1 (1 mg/1) for freshwater aquatic life, with values ranging from 1,500-4,100 ug/1. Sulfate concentrations were greatest, 170-290 mg/1, during the October or low flow sampling. The U.S. Geological Survey (1979) provided additional data on suspended sediment loads at these three monitoring points. Ranges for this parameter at each station were as follows: Hawley--4.3 tons/day (November) to 5,224 tons/day (April), total 6,850 tons for year; (2) Sabin--6 tons/day (August) to 3,254 tons/day (April), total 5,920 tons for year; (3) Dilworth--4.9 tons/day (September) to 12,210 tons/day (April), total 18,272 tons per year.

Groundwater quality data from wells at five communities in the subbasin are given in Table 10. These data indicate that nearly all parameters are high. The water is characteristically hard and high in total dissolved solids. In every community, iron concentrations exceed the EPA's (1976) criterion of 0.3 mg/1 for domestic supplies. Sulfate levels are also high in some communities, with values ranging from 55 mg/1 in Barnesville to 260 mg/1 in Callaway.

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SURFACE WATER QUALITY DATA FO
FRO

Description	Flow (cfs)	Temperature (°F)		D.O. (mg/l)		BOD_5 (mg/l)		NH_3 (mg/l)		Fecal Coliforms (MPN/100 ml)	
Water Quality Standards in this Segment		5 Max. change Max. 2B-86		2B* 2C**		--		2B-1.0		200	
Monitoring Stations	Average 7-Day 10-Year Low	Average Maximum	Percent of Violation	Average Minimum	Percent of Violation	Average Maximum	Percent of Violation	Average Maximum	Percent of Violation	Average Maximum	Percent of Violation
South Branch Buffalo River SBR-3.1; Bridge USH-75 30 reports, 1971-74	--	52	0	8.1	7	2.3	--	0.21	3	1985	30
		78		0.9		4.5		2.0		49,000	

*6 1/4-5/31; five rest of the year.

**5-4/1-11/30; four rest of the year.

Source: Minnesota Pollution Control Agency, 1975.

Table 8

...LITY DATA FOR THE BUFFALO RIVER AT U.S. HIGHWAY 75 FROM 1971-1974

Fecal Coliforms (MPN/100 ml)		TDS (mg/l)		pH		Turbidity (JTU)		Oil (mg/l)		NO_3 (mg/l)		Phosphorus (mg/l)	
200		700		6.5-9.0		25		2B-0.5		--		--	
Average Maximum	Percent of Violation	Average Maximum	Percent of Violation	Average Range	Percent of Violation	Average Maximum	Percent of Violation	Average Maximum	Percent of Violation	Average Maximum	Percent of Violation	Average Maximum	Percent of Violation
1985	30	364	0	7.9	0	25.6	37	--		0.5	0	0.33	
49,000		--		7.3-8.7		130				5.4		29	

2

8

HE BUFFALO RIVER AT U.S. HIGHWAY 75
971-1974

TDS (mg/l)	pH	Turbidity (JTU)	Oil (mg/l)	NO_3 (mg/l)	Phosphorus (mg/l)	TSS (mg/l)
700	6.5-9.0	25	28-0.5	--	--	--

Average		Average		Average		Average		Average		Average		Average	
Maximum	Percent of Violation	Range	Percent of Violation	Maximum	Percent of Violation	Maximum	Percent of Violation	Maximum	Percent of Violation	Maximum	Percent of Violation	Maximum	Percent of Violation
364		7.9		25.6				0.5		0.33		60	
	0	7.3-	0		37	--			0		--		--
--		8.7		130				5.4		29		280	

3

Table 9

SURFACE WATER QUALITY DATA FOR THE BUFFALO RIVER (HAWLEY AND DILWORTH) AND SOUTH BRANCH BUFFALO RIVER (SABIN) IN OCTOBER 1977 AND APRIL 1978

Parameter	State Criteria[1]	EPA Freshwater Aquatic Life Criteria[2]	Maximum			Minimum		
			Hawley	Sabin	Dilworth	Hawley	Sabin	Dilworth
Flow (cfs)	--	--	818	3,430	5,180	26	21	54
pH	6.5-9.0	6.5-9.0	7.8	7.8	8.1	6.9	7.1	7.0
Temperature (°C)	30°C(86°F) max.	--	—	--	--	0.0	2.0	1.0
Color (P+Co units)	--	--	50	60	50	28	50	37
Hardness (mg/l $CaCO_3$)	500 mg/l	—	490	620	540	130	140	120
Calcium (mg/l)	--	--	110	140	120	31	32	28
Magnesium (mg/l)	--	--	53	65	58	13	15	11
Sodium (mg/l)	--	--	22	20	20	3.3	5.0	4.5
Potassium (mg/l)	--	--	5.5	7.2	6.0	3.3	5.2	4.6
Alkalinity (mg/l $CaCO_3$)	--	20 mg/l min.	340	340	330	98	110	98
Sulfate (mg/l)	—	--	170	290	230	39	49	36
Chloride (mg/l)	250 mg/l	—	13	6.3	8.4	2.6	2.3	3.0
Dissolved Solids (mg/l)	700 mg/l	—	622	783	678	172	203	168
Total Nitrogen (mg/l N)	--	--	2.6	2.8	2.2	0.60	0.79	0.70
Total Phosphorus (mg/l P)	--	--	0.18	0.37	0.31	0.03	0.06	0.06
Iron (µg/l)	--	1,000 µg/l	1,600	4,100	1,500	330	40	290
Manganese (µg/l)	--	--	80	80	60	80	30	40

[1]From Minnesota Pollution Control Agency, 1975.

[2]From U.S. Environmental Protection Agency, 1976.

Source: U. S. Geological Survey, 1979.

Table 10

GROUNDWATER QUALITY DATA FROM COMMUNITIES IN THE BUFFALO RIVER SUBBASIN

Community	Well Depth (feet)	Operating Rate (gpm)	Total Dissolved Solids	Hardness	Iron	Sulfate
Barnesville						
Well 5	72	300	473	382	1.7	55
Well 7	73	60-70	--	--	1.8	--
Callaway						
Well 1	100	40	--	--	--	--
Well 2	110	40	--	530	1.2	260
Dilworth						
Well 4	155	65	--	137	1.5	--
Well 5	178	100	600	119	0.41	144
Hawley						
Well 5	142	127	--	--	--	--
Well 6	142	100	--	545	--	170
Lake Park	380	100	760	540	2.6	200

Source: Maclay et al., 1969.

Aesthetics

Buffalo River State Park, located east of Glyndon, is the major aesthetic attraction in the subbasin. There are 12,400 acres in the park, which offers 44 modern, pioneer, and group campsites. Picnic grounds, a swimming beach, and stream fishing in the Buffalo River afford water-based and related recreational opportunities. There are several miles of hiking trails, and the park is designated as a state cross-country ski area.

The eastern portion of the subbasin is characterized by morainal lakes and forests, which contrast to the level terrain of the valley and offer residents the opportunity to participate in outdoor recreational activities or simply to enjoy the scenic qualities of the area.

Cultural Elements

Evidence of early (Paleo) man in the subbasin is limited. As late as 9900 B.P., much of the Lake Agassiz plain was poorly drained, swampy, and somewhat inhospitable to early man. It is significant that in the Red River Valley as a whole, more early man sites are documented along the western perimeter of the glacial lake plain (Johnson, 1962). The forest-prairie transition zone, which transects the subbasin, had potentially profound impacts on the use of the area by prehistoric hunters and gatherers (Micholovic, 1978, all citations with the permission of the author and the Minnesota Historical Society). The correlation of cultural remains with glacial Lake Agassiz strandlines could further illuminate prehistoric settlement patterns and ecological adaptations in the valley and in the subbasin.

To date, only two archeological sites have been recorded officially for the subbasin; both are identified as Woodland mound sites. A recent archeological survey of Clay County should substantially alter this number. Micholovic (1978) reported that 48 sites were visited during the Clay County survey. Most (21) of the prehistoric sites located within the Lake Agassiz Basin of Clay County were situated along rivers and streams. The majority of artifact assemblages were found along the major rivers; smaller surface scatters were more characteristic of prairie sites (Micholovic, 1978). This apparent association of archeological resources with major

streams may have significant impacts on the development and implementation of flood control measures.

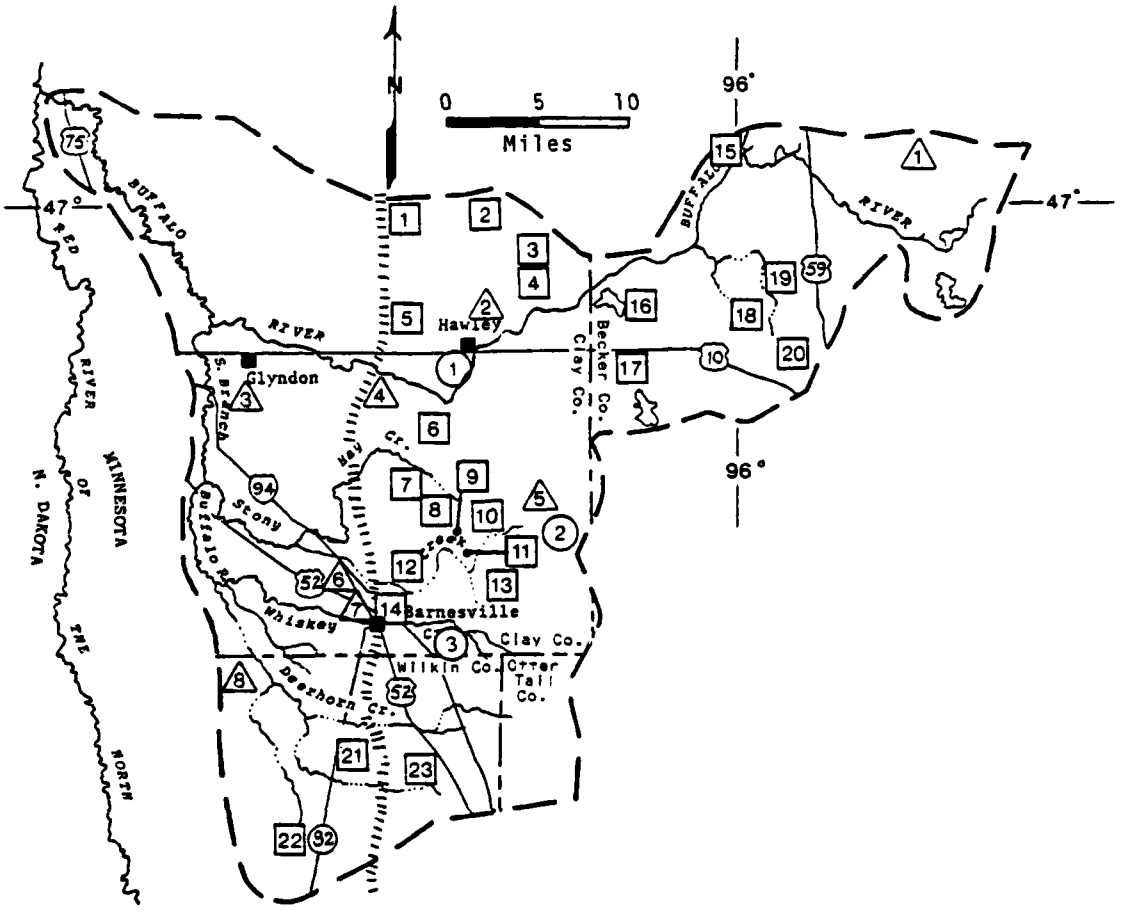
Historically, the subbasin was occupied primarily by related groups of the Dakota-Sioux Indians. A boundary established in 1825 separated the Sioux from their aggressive northern neighbors, the Chippewa; this boundary later became the basis for the Indian Land Sessions of 1837, which opened western Minnesota to white settlement (Blegen, 1963). Settlement of the subbasin by Euro-Americans increased after the Civil War. English, Germans, and New Englanders were among the pioneers (Blegen, 1963).

Precolumbian runestones, mooringstones, and Viking swords were located in the subbasin, but their authenticity remains questionable (Blegen, 1963; Micholovic, 1978). More positive evidence of European and American impact on the culture of the area is found in the 103 historical sites recorded within the subbasin. Of these, four are nominated for the National Register, although none are presently listed on the register.

Recreational Resources

Water-related recreational opportunities in the subbasin are associated primarily with the lake, marsh, and pothole region in the central and eastern portions of the area, as illustrated in Figure III. The subbasin's most important recreational resource is Buffalo River State Park, located about four miles east of Glyndon, which provides camping, fishing, swimming, and picnicking opportunities. The site, consisting of 12,400 acres, once formed a prairie oasis and Campbell Beach of Lake Agassiz. In addition to the state park, there are approximately 13,390 acres of recreational lands in the subbasin, 99.5 percent of which are more than 15 acres large. An inventory of facilities over 15 acres is included in Appendix B of this report.

There are 23 wildlife management areas in the subbasin that account for 12,185.6 acres or 91 percent of all recreational lands, excluding the state park. Common species attracting hunters include white-tailed deer, waterfowl, ruffed grouse, and pheasant. Muskrats, mink, and raccoons are among the furbearers found within the subbasin. In addition, there are numerous Federal Waterfowl Production Areas within the subbasin that are open to the public for hunting.



☐ EXISTING WILDLIFE AREAS

1 Jeral WMA
2 Cromwell WMA
3 Hitterdal WMA
4 Highland Grove WMA
5 Gruhl WMA
6 Hawley WMA
7 Magnusson WMA
8 Byornson WMA
9 Clay County WMA
10 Skree WMA
11 Hay Creek WMA
12 Jansen WMA
13 Barnesville WMA
14 I 94 Borrow Pit WMA
15 Riparia WMA
16 Cuba Wma
17 Lunde Wma
18 Audabon WMA
19 Callaway WMA
20 Richwood WMA
21 Atherton WMA
22 Manston WMA
23 Rothsay WMA

○ OTHER RECREATION AREAS

1 Hawley Municipal Golf Course
2 Royal Oak Snow Ski Area
3 Willow Creek Golf Course

△ EXISTING RECREATION AREAS

1 Big Sugar Bush Resort
2 Hawley Municipal Park
3 North Dakota Retriever Club
4 Buffalo River State Park
5 Granrud Farm Campground
6 Blue Eagle Lake Municipal Park
7 Barnesville Athletic Field
8 Weatern Prarie Science and Nature Area

Source: Gulf South Research Institute.

Figure III. RECREATIONAL RESOURCES

There is little stream fishery because of low flows and siltation, and lake fishery is confined to the deeper lakes. Walleye and northern pike, bullheads, bass, and pan fishes are the species most commonly taken.

Municipal recreational facilities include 206 acres of parks, athletic fields, and golf courses. Proposed recreational sites are limited to park expansion in the town of Hawley.

Significant Environmental Elements

Social

The towns of Barnesville, Hawley, and Glyndon are the population centers of the subbasin. These towns report minor damages as a result of flooding problems, and the damages usually occur in the form of water entering basements. All of the towns have passed ordinances prohibiting further development within the floodplain. County roads and ditches and some railroads have been affected by flooding, which has increased county maintenance costs.

The subbasin is primarily agricultural and is extensively cultivated, including areas within the floodplain. Flooding causes some damages to crops, but delay in planting is a more common problem. Loss of valuable topsoil and damages to farm equipment as a result of flooding present additional problems to area farmers. The towns in the subbasin are mainly agricultural service centers that are economically affected by decreases in yields and the resultant loss of income experienced by farmers in flood years.

Cultural

Only two archeological sites have been recorded to date within the subbasin. This lack of inventoried archeological resources is indicative of a lack of systematic research. Recent archeological surveys should substantially improve the cultural resources inventory.

Runestones and swords found within the subbasin vicinity are reputed to be artifactual evidence of Precolumbian European (Viking) exploration. Although the authenticity of these Viking artifacts remains in doubt, they do enhance the cultural landscape and folk tradition. The subbasin has 103 recorded historical sites, of which four are nominated for the National Register of Historic Places.

Soils

The various soils in the subbasin are separated into three distinctive groups. Soils in the West tend to be clayey and dark colored, poorly drained yet highly fertile. The soils near and within the beach area tend to be clay loams and sandy loams mixed with sands and gravels, all of which are poorly drained. The morainic area soils are mostly clays and silts, with those in the more irregular topography moderately well drained with a dark loamy texture and fair inherent fertility.

The Fargo soils in the western section of the basin are poorly drained and have limited irrigation potential. There are a few scattered saline spots in this area, and just as for the Beardon-Wheatville-Colvin soils in the same area, soil movement by wind is sometimes a problem. Soil problems in the beach area include a calcareous layer at or near the surface in some areas, moderate-to-poor drainage and excessive drainage within short distances, and susceptibility to wind movement. The wide variation of soil consistencies in this area creates numerous agricultural problems. Soils in the eastern portion are also varied, but primary management concerns are conserving moisture in some areas, controlling erosion, and maintaining fertility. Scattered areas in the morainic portion have a high lime content; other areas have a calcareous condition at or near the surface.

Water

In addition to the Buffalo River, there are a few small creeks located in the western part of the subbasin. Several small lakes in the eastern part of the subbasin contribute to the surface water area, which amounts to 2.7 percent of the total land area. The lakes are important for recreation, water supply, and fish and wildlife.

Woodlands

Woodlands and brushy areas in the subbasin are deemed significant because of their value as habitats for wildlife and because of their relatively limited areal extent. Data from the Minnesota Land Management Information Service (MLMIS) show that 44,360 acres, or about six percent of the total subbasin area, is forested. Agricultural lands comprise

nearly 90 percent of the remaining area. Comparisons of the percentages of woodland vegetation between 1960 and 1977 in the counties included by the subbasin are given in Table 11. These data indicate that woodland acreages are probably increasing, but as evidenced by the increase for Clay County, which comprises most of the area in the subbasin, the increase is probably minor. In data provided by the U.S. Fish and Wildlife Service (1980), it was disclosed that some of the increase can be attributed to establishment of shelterbelts and windbreaks of native and exotic tree and shrub species by local landowners around homesteads and tributary streams, and to revegetated areas in the lower reaches of the floodplain that have not been cultivated in recent years.

Table 11

COMPARISON OF COUNTY PERCENTAGES OF WOODLAND VEGETATION BETWEEN 1969 AND 1977

County	Percentage of County Containing Woodland Vegetation		Change in Percent Composition
	1969	1977	
Clay	2.8	3.0	+0.2
Becker	40.6	46.5	+5.9
Wilkin	0.6	0.7	+0.1
Ottertail	16.4	19.9	+3.5

Source: Minnesota Land Management Information Service (in U.S. Fish and Wildlife Service, 1980).

Wetlands

Wetlands are significant because of their many functional values, such as habitats for plants and animals, waterfowl production areas, floodwater retention, nutrient entrapment, groundwater recharge, etc. (Cernohous, 1979; U.S. Fish and Wildlife Service, 1980; Executive Order 11990, 24 May 1977). MLMIS data show that about 8,760 acres of marsh exist within the subbasin's boundaries. Table 12 gives 1964 wetland data for Types 1 and 3-5 in Clay, Becker, Wilkin, and Ottertail counties.

Table 12

1964 WETLAND INVENTORY DATA FOR THE FOUR COUNTIES IN THE BUFFALO RIVER SUBBASIN

	Wetland Types*									
	1		3		4		5		Total	
County	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Clay	1,574	1,411	1,881	3,687	567	3,548	176	2,169	4,198	10,815
Becker	1,207	1,332	1,748	5,174	180	2,779	84	924	3,219	10,209
Wilkin	166	506	241	1,187	32	2,058	4	125	443	3,876
Ottertail	7,025	6,656	9,218	18,710	1,434	12,193	1,057	13,469	18,734	51,028
TOTAL	9,972	9,905	13,088	28,758	2,213	20,578	1,321	16,687	26,594	75,928

*Type 1-Seasonally flooded basins or flats
Type 3-Shallow fresh marshes
Type 4-Deep fresh marshes
Type 5-Open fresh water

Source: U.S. Fish and Wildlife Service, 1980.

The 1964 data represent a 25 percent sampling. All numbers except for Type 1 have been multiplied by four to give 100 percent values for numbers and acreages of wetlands. Type 1 wetlands were not measured in the 1964 survey; however, previous studies have indicated that they comprise about 10 to 15 percent of total wetland acres and 60 percent of total wetland numbers in the Prairie Pothole Region. This information was used to calculate Type 1 estimates. The 1964 data (expanded to 100 percent) is a conservative estimate.

Table 13 shows wetland numbers and acreages for 1974; this sampling represented a 100 percent inventory. In addition to the wetland types surveyed in the 1964 investigation, exclusive of Type 1 wetlands, Types 6 and 7 and stockponds are included. Table 14 shows a comparison of the 1964 and 1974 wetland inventory data for Types 3 to 5.

These data are comparable, since methods used in the 1974 survey allowed direct comparison of the same sampling locations at the 25 percent level sampling. The data in Table 14 show that the number and acreage of Types 3, 4, and 5 wetlands were reduced by 6,271 and 4,953 acres, respectively, during the 10-year period from 1964 to 1974.

As discussed earlier in the Existing Conditions section, wetlands within the Border-Transition zone have been classified by Mann (1979) as first and third priority for wetland preservation; classes 1 and 2 represent the highest wetland densities (Figure IV). All priority ratings are for wetland preservation in the prime agricultural and agricultural transition areas of the state that contain major wetland concentrations.

Waterfowl Production Areas

Waterfowl Production Areas (WPA's) are wetland areas that the U.S. Fish and Wildlife Service (USFWS) has either acquired through fee title or obtained an easement interest on to preserve valuable breeding, nesting, and feeding habitat for migratory waterfowl. These wetland areas are purchased, or an easement interest obtained, with funds received from the sale of Migratory Bird Hunting and Conservation Stamps ("Duck Stamps"). These WPA's are significant because they provide the public with a great variety of wildlife-oriented recreational opportunities as well as providing valuable habitat for migratory waterfowl and many other forms of wildlife.

Table 13

1974 WETLAND INVENTORY DATA FOR THE FOUR COUNTIES IN THE BUFFALO RIVER SUBBASIN

	Wetland Type															
	3		4		5		6		7		8		Stock Ponds		Total	
County	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres	Number	Acres
Clay	1,299	7,338	311	3,671	158	5,652	393	7,249	61	673	--	--	165	--	2,387	24,583
Becker	1,688	15,520	210	9,700	103	12,843	87	1,935	--	--	--	--	37	--	2,125	39,998
Wilkin	108	3,614	15	218	3	177	9	28	--	--	--	--	32	5	167	4,042
Ottertail	4,127	16,217	2,110	20,275	1,251	31,128	1,877	11,986	23	408	9	153	288	33	9,685	80,200
TOTAL	7,222	42,689	2,646	33,864	1,515	49,800	2,366	21,198	84	1,081	9	153	522	38	14,364	148,823

Source: U.S. Fish and Wildlife Service, 1980.

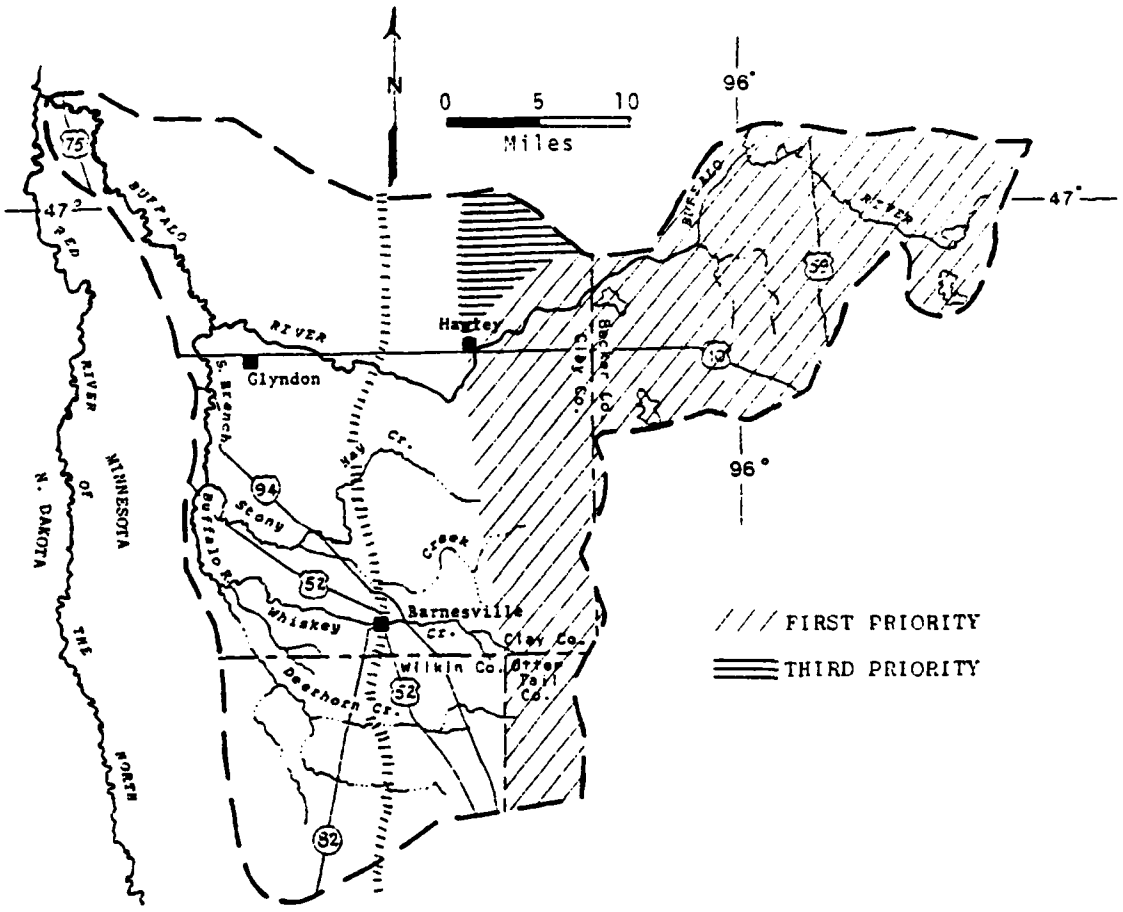
Table 14

COMPARISON OF 1964 AND 1974 WETLAND INVENTORY DATA SHOWING NUMBER, ACREAGE, AND PERCENT CHANGES FOR COUNTIES IN THE BUFFALO RIVER SUBBASIN[a]

	Wetland Types															
	3				4				5				Total			
County	Number	Percent	Acre	Percent	Number	Percent	Acre	Percent	Number	Percent	Acre	Percent	Number	Percent	Acre	Percent
Clay	-418	-22.2	+472	+12.8	-300	-52.9	-1,154	-32.5	-60	-34.1	-400	-18.4	-778	-29.6	-1,082	-11.5
Becker	-844	-48.3	-217	-4.2	-120	-66.7	-1,246	-44.8	-72	-85.7	-384	-41.6	-1,036	-51.5	-1,847	-20.8
Wilkin	-147	-61.0	-337	-28.3	-5	-15.6	+516	+25.0	--	--	-61	-48.8	-152	-54.9	+117	+3.4
Ottertail	-5,094	-55.3	-3,676	-19.6	+801	+55.9	+1,264	+10.3	-12	-1.1	+270	+2.0	-4,305	-36.8	-2,143	-4.8
TOTAL	-6,503	--	-3,758	--	+376	--	-620	--	-144	--	-575	--	-6,271	--	-4,953	--

[a]Represents values expanded to 100 percent from a 25 percent sample.

Source: U.S. Fish and Wildlife Service, 1980.



Source: Mann, 1979.

Figure IV. PRIORITY RANKINGS OF WETLANDS IN NEED OF PRESERVATION

The USFWS is responsible for the compatibility determinations (uses) and the issuance or denial of permits involving these lands. The approximate locations of these WPA's (fee tracts) within the subbasin are shown in Figure V. Total acreage of these WPA's (fee and easement) within Becker, Clay, Ottertail, and Wilkin Counties, Minnesota are given in Table 15.

Table 15

ACRES OF FEDERAL WATERFOWL PRODUCTION AREAS
(FEE AND EASEMENT) WITHIN THE BUFFALO RIVER SUBBASIN

County	Fee (Acres)	Easement (Acres)	Total Acres
Clay	7,063	1,330	8,393
Becker	9,458	463	9,921
Wilken	1,247	167	1,414
Ottertail	15,265	5,365	20,630
TOTAL	33,033	7,325	40,358

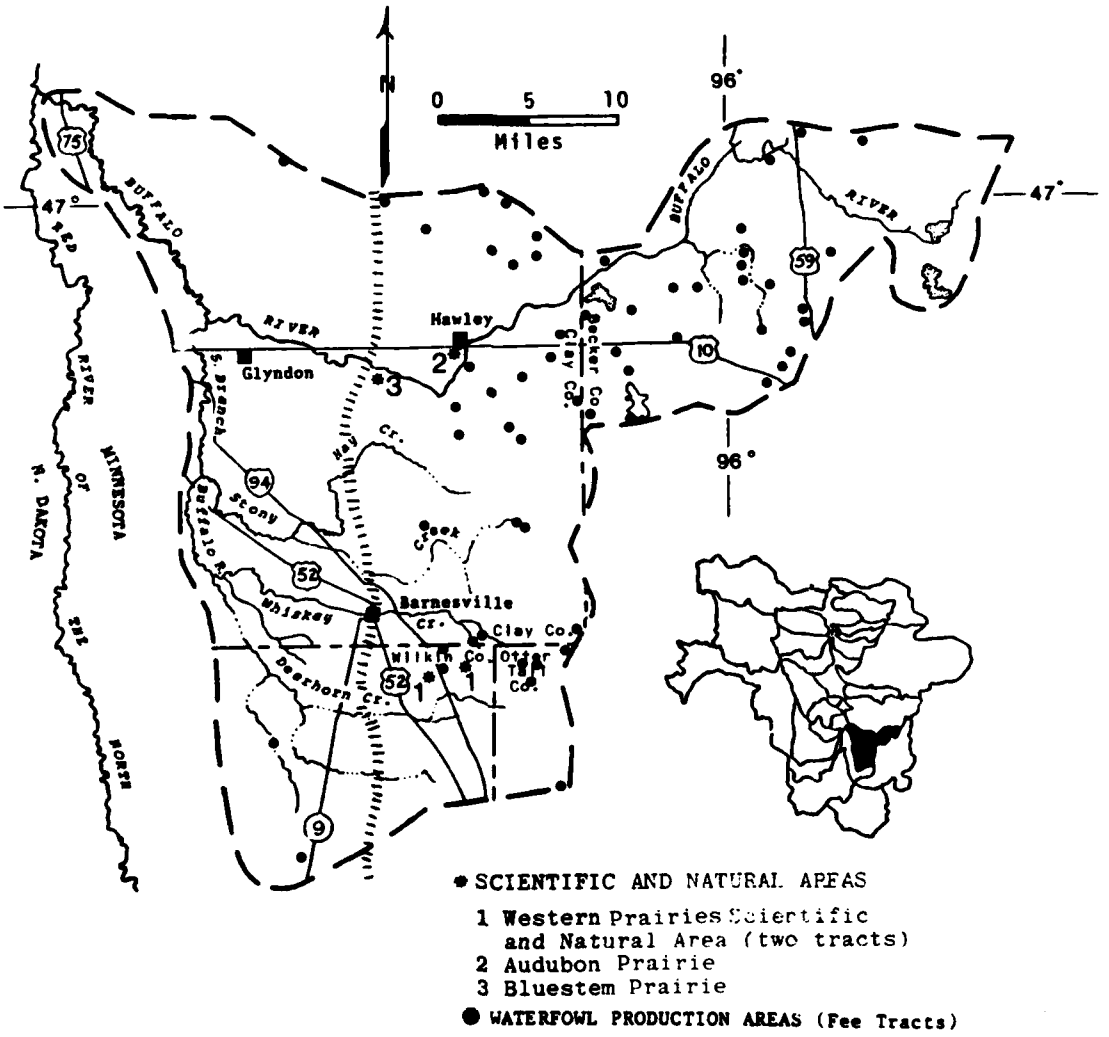
Source: Annual Report of Lands Under Control of the U.S. Fish and Wildlife Service as of September 30, 1978. U.S. Department of the Interior, Division of Realty, Washington, D.C.

Wildlife Management Areas

A total of 23 wildlife management areas occur within the subbasin. A listing of these areas (along with acreages and locations) was given in the earlier Recreation section. These areas are considered significant because of the opportunities provided for outdoor recreation and the protection and management given to biological resources within their limits.

Threatened or Endangered Species

The bald eagle and the Arctic peregrine falcon, which have been designated to be threatened or endangered, are known or presumed to occur within the subbasin. The bald eagle has known nesting sites in Becker and Ottertail counties. Numerous lakes in these counties provide the bald eagle's primary food source of fish. Although the Arctic peregrine falcon does not nest in this area, the entire subbasin is included within



Source: The Nature Conservacy (no date); Miles and Yaeger (1979); U.S. Fish and Wildlife Service (1980).

Figure V. WATERFOWL PRODUCTION AREAS AND SCIENTIFIC AND NATURAL AREAS

its wintering range. Clay County provides critical habitat of virgin prairies for a proposed threatened species, the Dakota skipper butterfly (U.S. Fish and Wildlife Service, 1979; McCabe and Post, 1977).

Other Important Species

Mammals having a priority status (Henderson, 1979) that are known or presumed to occur within the subbasin are the long-tailed weasel, wolverine, spotted skunk, cougar, northern grasshopper mouse, and American elk. The long-tailed weasel and cougar are considered peripheral species that would occupy only a small range within the subbasin. The wolverine and American elk are peripheral species also, but these have, for the most part, been extirpated from this region. Because of unique habitat requirements and declining size in range or populations, the northern grasshopper mouse and the spotted skunk are listed as priority species (Henderson, 1979). The bobcat is listed as a species of special interest by Moyle (1974).

The white pelican, double-crested cormorant, marsh hawk, and Franklin's gull were all reported within the subbasin region during the 1978 breeding bird survey (Henderson, 1978). All four species have been identified as having a changing or uncertain status (Moyle, 1974) because they are uncommon or local. The marsh hawk is presently increasing its population, however. Bird species of special interest that were also reported in the 1978 survey include the common loon and the great blue heron. Neither of these is apt to become threatened or endangered, but both should be closely watched because of the vulnerability of their preferred feeding habitats and nesting sites. Only one colonial bird nesting site is located within the subbasin. The site, located in Clay County, was used by a single pair of western grebes in 1978 (Minnesota Department of Natural Resources, 1978).

There are no species of threatened or endangered herptiles that occur in the subbasin. However, the smooth green snake is a species of special interest, since it is restricted to certain limited habitats consisting of meadows or plains that have moist grassy areas (Henderson, 1979; Conant, 1975). The Canadian toad and the great plains toad are two western species that occur in the subbasin, which is at the extreme eastern edge of the toads' ranges.

Natural Areas

Three natural areas are located within the subbasin: (1) Western Prairies Scientific and Natural Area; (2) Audubon Prairie; and (3) Bluestem Prairie. The Western Prairie, separated into two tracts, is located in Wilkin County. The prairie is an exceptional example of a lowland tall grass prairie. Additionally, it supports prairie chickens, deer, upland plover, marbled godwit, and two populations of orchids, the white ladyskipper and ladies' tresses. Together, the two tracts comprise about 600 acres. The Audubon Prairie is located in Clay County, approximately eight miles southwest of Hawley, and encompasses about 240 acres. It is a wet-to-mesic prairie located in the lake bed of Glacial Lake Agassiz. Audubon Prairie supports a variety of prairie flora. Several prairie chicken booming grounds have been established in the area. Approximately seven miles east of Moorhead is located "one of the finest and largest remaining undisturbed virgin prairies in Minnesota" (The Nature Conservancy, no date). This area is known as the Bluestem Prairie and supports over 300 species of prairie flora as well as a stable population of prairie chickens. The total acreage for the Bluestem Prairie is 880 acres (The Nature Conservancy, no date; Minnesota Department of Natural Resources Scientific and Natural Areas Files, July, 1977). The locations of all three natural areas are shown in Figure V.

V. FUTURE CONDITIONS

V. FUTURE CONDITIONS

The following discussion of the subbasin focuses on a presentation of "most probable" and "without project" future economic and population conditions and likely environmental aspects.

Most Probable Economic Conditions

As required by the Principles and Standards, consideration was given to the adoption of OBERS Series E and E' projections of general economic and demographic parameters for the non-SMSA portion of the Fargo-Moorhead area. The present study found, however, that recent trends have shown a stabilization and in some cases a reversal of past steady decreases in population and employment within the subbasin. State, regional and GSRI developed projections are therefore recommended as the most probable for such statistics. OBERS Series E and E' per capita income and future agricultural activity projections have nevertheless tracked adequately and were thus deemed adequate for the purposes of this reconnaissance investigation.

Table 16 presents population, employment, and per capita income (expressed in 1979 dollars) figures for the subbasin.

Table 16

BUFFALO RIVER SUBBASIN POPULATION, EMPLOYMENT, AND PER CAPITA INCOME PROJECTIONS 1990-2030

Parmeter	1970	1977	1980	1990	2000	2010	2020	2030
Population	15,352	17,694	18,300	19,500	21,000	22,700	24,500	26,500
Employment	5,834	7,962	8,100	8,800	9,500	10,200	11,000	11,900
Per Capita Income (1979 dollars)	$ 5,468	$ 6,892	$ 9,000	$11,700	$15,200	$19,700	$25,600	$33,300

Sources: U.S. Water Resources Council, 1972 OBERS Projections, Series E; West Central (Minnesota) Regional Development Commission; and Gulf South Research Institute.

These figures reflect the continued influence of the Fargo-Moorhead area, particularly the latter city. According to the West Central Regional Development Commission, the area influences a 15-mile to 30-mile radius region and has been growing at a rate more than twice Minnesota's average. Hawley and Glyndon are located within this radius and will continue to develop as a result of suburbanization and their favorable location on the main route to the recreation areas to the east. Barnesville will continue to expand its scope of influence, particularly in the agricultural trade and services sectors.

Most Probable Agricultural Conditions

Roughly 586,000 acres within the subbasin are currently under cultivation, and wheat, barley, sunflowers and hay are the principal crops. The estimated value of the total production of these principal crops for 1980, using October 1979 Current Normalized Prices for Minnesota, is $32.8 million. Projections of total production through 2030 for the principal crops grown in the subbasin are presented in Table 17. The projected total production for 2030 represents a total value of 60.3 million, using October 1979 Current Normalized Prices for Minnesota.

Table 17

BUFFALO RIVER SUBBASIN, PRINCIPAL CROPS AND PROJECTED PRODUCTION, 1980-2030
(Production in Thousands)

Year	Wheat (Bushels)	Barley (Bushels)	Sunflowers (Pounds)	Hay (Bushels)
1980	5,?55	4,081	101,984	85
1990	6,096	4,734	118,301	99
2000	6,937	5,387	134,510	112
2010	7,462	5,795	144,817	121
2020	7,989	6,203	155,016	129
2030	8,288	6,856	171,333	143

Sources: OBERS Series E'; Gulf South Research Institute.

Evaluation of Flood Damages--Future Conditions

A summary of present and future average annual flood damages is presented in Table 18. Assuming a discount rate of 7 1/8 percent, average annual damages throughout the projection period are expected to be $1,733,000.

Flood damages to residences, businesses, industrial structures, churches, schools, automobiles, house trailers, public property and contents are included in the urban damages category. Damages to streets and utilities (including water, gas, electricity, sanitary sewers, storm sewers, and telephone systems) are also taken into consideration. This category also includes loss of wages, loss of profits, expenditures for temporary housing, cleanup costs, and extra expenses for additional fire and police protection and flood relief.

Agricultural flood damages consist of crop and pasture damage, which may include costs of replanting, refertilizing, additional spraying, reduced crop yields, loss of animal pasture days, and other related flood losses.

Other agricultural damages consist of land damage from scour and gully erosion and deposition of flood debris; livestock and poultry losses; damages to machinery and equipment, fences, and farm buildings and contents (excluding residences); and damages to irrigation and drainage facilities.

Transportation damages include all damages to railroads, highways, roads, airports, bridges, culverts, and waterways not included in urban damages. In addition, all added operational costs for railroads and airlines and vehicle detours are included.

Future growth of urban flood damages was estimated to be an uncompounded (straight-line) rate of one percent per year for a 50-year period beginning in the base year, with no growth thereafter.

Agricultural crop flood damages were projected to increase at the same rate as crop income projections published in the 1972 OBERS Series E projection report. These crop income projections were prepared by the U.S. Economic Research Service (ERS) for the Red River of the North region. Other agricultural flood damages were projected to increase at one-half of this rate.

Transportation damages are not expected to change throughout the project life because of the long-term economic life associated with such

Table 18

BUFFALO RIVER SUBBASIN, SUMMARY OF PRESENT AND FUTURE AVERAGE ANNUAL DAMAGES URBAN, AGRICULTURAL, AND TRANSPORTATION (October, 1979 Prices, 7 1/8 Percent Interest)

Category	Flood Damages						Increase 1980-2030	Average Annual Equivalency Factor	Average Annual Equivalency of Increase	Equivalent Average Annual Damages
	1980	1990	2000	2010	2020	2030				
Urban										
Barnesville	6,600	7,300	7,900	8,600	9,200	9,900	3,300	0.2903	1,000	7,600
Agricultural										
Crop	1,014,400	1,176,700	1,339,000	1,440,400	1,541,900	1,704,200	689,800	0.2903	200,200	1,214,600
Other Agricultural	338,100	365,100	392,200	409,100	426,000	453,100	115,000	0.2903	33,400	371,500
Transportation	139,300	139,300	139,300	139,300	139,300	139,300	--	--	--	139,300
TOTAL	1,498,400	1,688,400	1,878,400	1,997,400	2,116,400	2,306,500	808,100	0.2903	234,600	1,733,000

Source: Gulf South Research Institute.

structures as bridges, railways, roads, and culverts. In addition, it has been found that repairs to these types of structures rarely exceed the cost of a new structure, even with frequent flooding.

Most Probable Environmental Conditions

As adequate treatment measures are employed by the municipal and industrial point sources of pollution in the subbasin, water quality improvements will be noted. Surface water quality should also improve with implementation of nonpoint source controls; however, it is expected to take a substantially longer period of time for the nonpoint controls to be implemented. Periodic violations with the dissolved oxygen parameter are expected to continue in those winters when ice cover inhibits reaeration.

Woodland wildlife habitats are expected to increase at a slow rate contingent upon continuing land use trends noted from 1969 to 1977. Inventory data, comparable between 1964 and 1974, indicate that wetlands will continue to decline in number and areal extent. This action will result in decreases in floral and faunal populations using these habitats, as well as their other valuable functions. Improvements in water quality (appreciably longer for nonpoint sources of pollution) will result in improved habitats for aquatic biota and wildlife utilizing surface waters.

Without Project Conditions

It is likely that the scenario set forth as the most probable future of the subbasin will prevail during the 50-year planning period in the absence of a plan to alter resource management programs.

VI. EXISTING FLOODPLAIN MANAGEMENT PROGRAMS

VI. EXISTING FLOODPLAIN MANAGEMENT PROGRAMS

Institutions

The development of effective water resources management practices in the subbasin is affected by the large number of Federal, state, and local agencies involved in project planning and implementation. There are 44 Federal agencies with various types of jurisdiction, and 14 directly involved in the water and related land resource planning process. At the state level, 27 agencies are involved. There are also regional commissions, county agencies, and municipal entities. Differences in perspective and problems of coordination hamper the effective and speedy resolution of problems.

The subbasin is aided in its water resources development by its inclusion in the Buffalo-Red River Watershed District, which was formed through an expansion of the South Buffalo District. The district has formulated an overall water management plan for the watershed.

The major Federal agencies with water resource development interests in the area are the Soil Conservation Service (SCS) and the St. Paul District Corps of Engineers. The Corps of Engineers has not constructed any flood control projects in the subbasin. However, the SCS has developed a plan for flood prevention and wildlife protection for the South of Hawley-South Buffalo Watershed area. Planning assistance, however, has been suspended in this watershed. A preliminary investigation was also completed by the SCS for the Deerhorn-Buffalo Creeks Watershed area, but planning assistance on this project was also terminated. The Corps of Engineers completed a Section 205 Reconnaissance Report in December 1978 for the Buffalo River at Georgetown. This report evaluated proposals of ring levees and a combination of ring levees and flood proofing in that community. No economically feasible solutions were found.

In addition to the Federal agencies, there are four soil and water conservation districts with authority in the subbasin: Clay County SWCD, Becker County SWCD, Wilkin County SWCD, and Ottertail SWCD.

The Corps of Engineers, the SCS, the four soil and water conservation districts, and the towns located within the subbasin are the main entities

that should be taken into consideration in flood control planning for the subbasin. Any projects located on White Earth Indian Reservation would require coordination with the Bureau of Indian Affairs and the reservation Tribal Council. It should also be noted that the West Central Regional Development Commission (WCRDC) has developed an overall economic development plan that includes the subbasin area.

Structural Measures

More than 317 miles of man-made channels are located throughout the subbasin. Over the years, these channels have been constructed by residents through legal means, with flood control as the major objective. As flood control was gradually attained, at least to a fair degree, residents of the area then looked to these channels for the purpose of drainage.

No Federal flood control projects have been constructed in the subbasin. Studies were sponsored by the U.S. Soil Conservation Service under its Public Law 566 program for South of Hawley-South Buffalo and Deerhorn-Buffalo watersheds. Viable projects for reducing flood damages were found in both watersheds. However, after completion of the studies, no subsequent actions have been taken regarding either watershed.

No flood damage reduction improvements are either authorized or planned within the subbasin.

Nonstructural Measures

Nonstructural flood control measures are measures that reduce or eliminate flood damages through procedures that involve little, if any, construction efforts. Such measures lessen the susceptibility of land, people and property to the impacts of flooding. They do not, however, modify the behavior of floodwaters. The major types are flood warning, floodplain zoning, flood insurance, flood proofing, and floodplain evacuation. These measures are primarily applicable to urban areas. Urban flood damages in the subbasin are substantial, and numerous nonstructural measures have been instituted, including:

1. Flood insurance in Ottertail County.
2. Flood insurance and floodplain zoning ordinances in Becker County.

3. Flood insurance, floodplain zoning ordinances, and subdivision regulations for floodplain areas in Wilkin and Clay counties.

4. Flood insurance in Barnesville, Georgetown, Glyndon, and Hawley. In addition, Glyndon has floodplain zoning along the creek, and Barnesville and Hawley are presently implementing floodplain zoning programs.

All of the towns in the subbasin participate in the Red River Valley flood warning system. The flood warning system for the Red River Valley is a cooperative network organized by the National Weather Service in Fargo, North Dakota. Fifty volunteers throughout the basin report to the National Weather Service on a weekly basis during winter and fall and on a daily basis during spring and summer. The reportage covers all precipitation of 0.1 inch or more, including amount of snow and water equivalent. This information is transmitted to the River Forecast Center in Minneapolis, where it is run through a computer system to determine probable flood stages. The predictions are then transmitted to the National Weather Service in Fargo, which releases them to the public through the news media. Communities are then able to engage in emergency actions to protect themselves from flood damages. Contacts with local officials indicate that the flood warning system generally works quite well in the subbasin.

There are other types of measures that could be used in the subbasin to provide limited reductions in flood damages that are not directly applicable to urban areas. These measures would include such things as land treatment programs, use of present drainage ditches for floodwater storage, use of natural areas for water retention, and acquisition of previously drained natural areas for reversion to water retention use. Land treatment is used by some farmers in the subbasin, but the SCS has not been called upon to undertake a large-scale program. Present drainage ditches are not used for floodwater storage, and no plans have been developed for future use. Information on natural storage areas and potentialities for increased storage is limited. Indications are, however, that wetlands play a substantial role in controlling runoff, especially in combination with good land treatment practices.

Adequacy of Existing Measures

Existing flood control measures in the subbasin are minimal. There are no large-scale structural measures to control flooding, and there are significant opportunities for use of nonstructural measures, particularly land treatment. Agricultural flood damages in teh western portion of the subbasin are significant.

VII. CRITERIA AND PLANNING OBJECTIVES

VII. CRITERIA AND PLANNING OBJECTIVES

Floodplain Management Criteria

Technical, economic, and environmental criteria must be considered when formulating and evaluating alternative floodplain management measures for the subbasin.

The technical criteria used in formulating and evaluating alternatives for this report consisted of the application of appropriate Federal engineering standards, regulations, and guidelines.

Economic criteria entailed the identification and comparison of benefits and costs of each measure. Tangible economic benefits must exceed costs; however, in certain instances, considerations of appropriate gains in the other accounts (environmental quality, social well-being and regional development) could alter this requirement. All alternatives considered are scaled to a design which optimizes benefits. Annual costs and benefits are based on an interest rate of 7 1/8 percent and price levels and conditions existing in October 1979. A 50-year amortization schedule is used for the features considered.

Environmental considerations call for the formulation of measures that minimize objectionable or adverse environmental effects and maximize environmental benefits. Also, limited consideration was given to modifications based on coordination with state and Federal agencies, local interests, and citizen groups.

Planning Objectives

The primary planning objective of this study was to contribute to flood reduction needs in the subbasin and thereby provide protection from or reduction of flood losses. In conjunction with this economic objective, the study attempted to develop contributions to the environmental quality of the subbasin.

The development of planning objectives involved a broad-range analysis of the needs, opportunities, concerns, and constraints of the subbasin. On the basis of the identified problems, needs, and desires, the following planning objectives were established:

(1) Contribute to protection from and prevention, reduction, or compensation of flood losses for the flood prone areas of the subbasin during the period of analysis.

(2) Contribute, to the maximum extent possible, to the preservation of the quality of the existing riverine environment and enhance the environmental potential of the subbasin as a whole.

(3) Contribute to the enhancement of recreational opportunities throughout the subbasin.

(4) Contribute to the improvement of water quality in the lakes and in the Buffalo River.

(5) Contribute to the improvement of water supply in the beach ridge portion of the subbasin, where many existing wells go dry in the summer, and in the western portion of the subbasin.

(6) Contribute to the reduction of wind and water erosion throughout the subbasin.

(7) Contribute to the developing trend toward increased irrigation throughout the subbasin.

(8) Contribute to the reduction of wastewater management problems, particularly insofar as they relate to water quality.

(9) Contribute to wetland preservation.

VIII. FORMULATION OF ALTERNATIVE MEASURES

VIII. FORMULATION OF ALTERNATIVE MEASURES

This section includes discussions of the management measures that have been identified from previous studies and investigations and that have been formulated to meet the resource management objectives. In the formulation of measures, prime consideration was given to the resolution of flooding problems. Measures to meet the other planning objectives were considered exclusively as components of the flood control measures.

Structural Measures

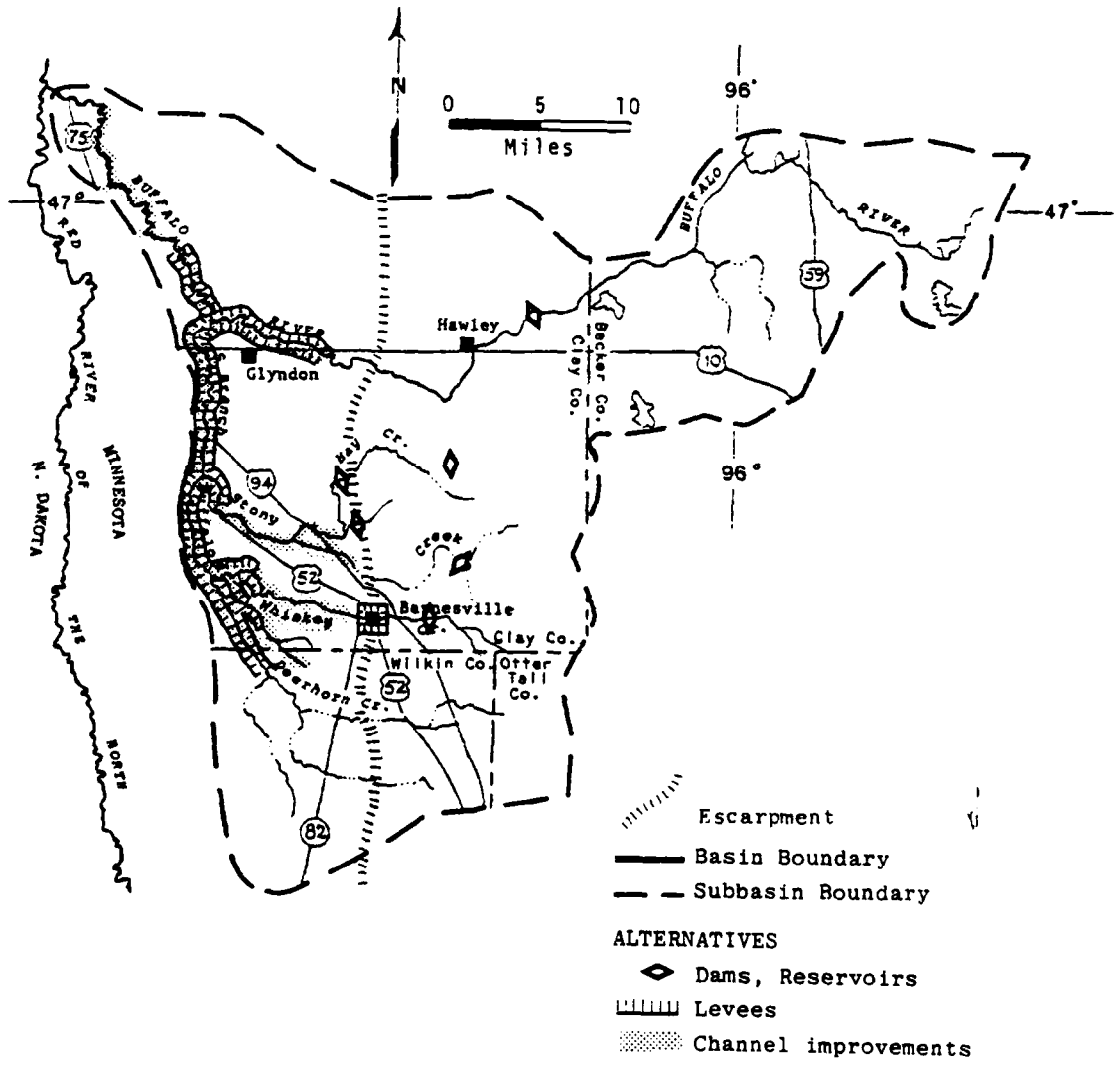
The following measures, shown in Figure VI, were indentified and devised in response to the flood control planning objective:

1. The 1961 Work Plan for protection and flood prevention in South of Hawly-South Buffalo Watershed proposed the following improvements:

   a. Three floodwater retarding structures and two multipurpose structures (flood prevention and wildlife). These five reservoirs would receive runoff from a total drainage area of 110 square miles and would have a total planned capacity for 9,290 acre-feet of storage (7,832.5 acre-feet of floodwater). The structures would furnish a 66.6 percent reduction in discharge at the watershed outlet into the South Branch of the Buffalo River for a 25-year frequency storm.

   b. A total of 38.5 miles of channel improvements on Hay Creek, Stony Creek, and Whisky Creek. The improved channels are designed to contain flood flows expected to occur no more frequently than once in 10 years (10 percent).

   c. Land treatment for 25,860 acres. Watershed land would be used within its capacities, and land treatment measures would be applied in accordance with needs. These measures will be planned and applied farm by farm within the watershed consistent with the estimate of needs and the anticipated accomplishments that the sponsoring organizations feel could be done during the installation period.



Source: Gulf South Research Institute.

Figure VI. ALTERNATIVE FLOOD CONTROL MEASURES

The proposed structural and land treatment measures would control flooding, runoff, erosion, and sediment on 40,213 acres in the flat western portion of the watershed and would directly affect 153 farmsteads (representing 700 persons) and the villages of Baker, Barnesville, and Downer. Land treatment measures proposed in the rolling eastern portion of the watershed, the three floodwater retarding structures, and the two multiple-purpose structures would control runoff, erosion, and sediment from 70,317 acres. There are approximately 281 farmsteads (representing 1,150 persons) in this area.

2. The Corps of Engineers conducted an interim survey in 1971 to develop a practical and socially acceptable flood damage reduction plan for the subbasin that would meet the objectives of national economic development, regional development, environmental quality, and social well-being. Alternatives identified during this survey were:

   a. New channel construction and existing channel improvements. This alternative would involve the construction of a 4.5-mile channel to the Red River to divert flows away from the lower reach of the Buffalo River and channel modifications extending 39 miles upstream from the diversion channel. This plan was determined to be infeasible, since the cost would more than double the benefits obtainable through flood stage reduction. Thus, it has not been reevaluated in this report and is not illustrated in Figure VI.

   b. Existing channel modifications. Under this alternative, 25 miles of the lower reach of the Buffalo River would be cleared and snagged, and several channel cutoffs would be constructed. The cutoffs would permit normal river flow through the regular channel and reduce flood stages by conveying flood flows across the channel bends. According to the interim survey, such a cutoff plan would minimize the impact on the natural river valley environment. However, the adverse environmental impact on the wooded river valley would be greater because of the greater river length included in the improved reach.

   c. Construction of an impoundment on the Buffalo River upstream from Hawley for flood control and recreation. This reservoir would provide floodwater storage for 51,000 acre-feet. Protection against a 1.0 percent (100-year) flood frequency would be provided for Hawley, along with a high degree of flood protection for the reach above the mouth of the South Branch. However, flooding in this reach of the Buffalo River is minimal. Most of the high flows along the lower Buffalo River are attributed to the South Branch

Buffalo River; consequently, this reservoir would be ineffectual in reducing flood damage along the Buffalo River below the mouth of the South Branch

3. Improvement of 96 miles of the Buffalo River and the South Branch. Channel modifications to the Buffalo River would consist of 59.5 miles extending from the Red River to U.S. Highway 10 near Stockwood. The South Branch channel would be improved from the mouth to the Clay-Wilkin county line, a distance of about 36.5 miles. The channels would be modified to contain a 10 percent (10-year) frequency flood and would provide protection for about 9,900 acres of farmland. The implementing agency could be either the SCS or the Corps.

4. Improvement of 11 miles of the Buffalo River from the mouth of the South Branch to U.S. Highway 10 near Stockwood. The channel would be modified to contain a 30 percent (3-year) frequency flood and would provide protection for about 3,300 acres of farmland. The implementing agency could be either the SCS or the Corps.

5. Agricultural levees along each side of the Buffalo River and the South Branch that would meet the recently devised Minnesota-North Dakota agricultural levee criterion stipulating that flood stages should not be increased more than 0.5 feet. The levees, which would provide protection against a 1.0 percent (100-year) frequency flood for the entire basin, would be 31 miles in length and would begin about at the gaging station near Dilworth and extend along both sides of the Buffalo River to the fork of the Buffalo River and the South Branch Buffalo River. From this fork, levees would extend along either side of the Buffalo River toward Hawley to U.S. HIghway 10 and along either side of the South Branch to the Clay-Wilkin county line. Levees would also be required for short distances along Stony and Whiskey creeks. The floodplain within the levees would vary from 4000 feet to 800 feet in width. About 14,800 acres would be afforded protection from a 100-year frequency flood.

6. Construction of levees at Barnesville. In the Summer of 1975, Barnesville sustained $484,000 in damages from overflow from Whiskey Creek. Levees along both sides of the creek at Barnesville would prevent a recurrence of these damages and would provide protection for Barnesville against a 1.0 percent (100-year) frequency flood.

7. Construction of levees around farmsteads in the flood-prone areas averaging 5.0 acres in size. These levees would provide protection against a 1.0 percent (100-year) frequency flood and could be constructed by private individuals, the SCS, or the Corps.

Engineering Methodology

All structural alternatives were analyzed on the basis of the effects of 1.0 percent (100-year), 10 percent (10-year), and 30 percent (3.3-year) floods originating within the subbasin. In developing the various alternatives, flood probability versus discharge curves were used to generate drainage area versus discharge curves for the 1.0, 10 and 30 percent floods. Stream cross-sections were estimated from U.S.G.S. quadrangle maps, and data from gage rating curves were used to delineate the various floodplains. From these data, area flooded versus chance of exceedence in one year curves for the various channel improvements and levee alternatives were developed, which in turn were used to estimate average annual benefits. A detailed analysis of U.S.G.S. quadrangle maps revealed approximately 3,000 acres of woodlands within the 100-year floodplain. Most of these woodlands are situated within the 1,000-foot requirement for levees with a 500-foot minimum setback. Since the quadrangle maps are dated from 1964 through 1966, the following assumptions were used: (1) woodlands flooded would be within 500 feet of the channel; and (2) the total woodland area has been reduced by one-third since 1966. It should be noted that this assumption may be incorrect, since the number of woodland acres within the subbasin has remained fairly stable over the past decade. Specific information on floodplain forest acreage would be needed before a more sepcific determination could be made.

Hydrological data on the subbasin were limited, and analyses and resulting estimates of benefits and capital costs were determined on the basis of these limited data, hydrological data from similar subbasins, and the contractor's experience and judgement. Capital cost estimates for levee alternatives include the cost of pumping facilities. Analysis of pumping costs is based on using portable pumping units with capacity for a 20 percent (5-year) frequency flood.

Capital costs were derived from either updating cost estimates from prior reports to October 1979 levels, or applying October 1979 unit construction costs. Construction cost indexes from Engineering News Record publications formed the basis for the updating of prior estimates of cost.

Nonstructural Measures

For those towns in which floodplain regulation is not in effect, this would be a viable alternative in limiting the growth of urban damages. However, in this, as in most subbasins, the primary damages are agricultural in nature and would not be affected by urban nonstructural measures. In addition, it should be noted that Glyndon already has floodplain zoning, and Barnesville and Hawley are in the process of implementing floodplain zoning ordinances. There is an opportunity for the use of land treatment measures throughout the subbasin that would help to contain water on land as well as reducing erosion damages. This has been considered as a component of one of the structural measures described above for a restricted geographic area (South of Hawley-South Buffalo); but the techniques could have much wider application. Potentials for water retention in existing ditches should be considered. Natural retention areas should be considered for preservation. However, these would need to be identified, and their retention capacities would need to be determined. In addition, there may also be opportunities for wetland restoration.

IX. ASSESSMENT OF ALTERNATIVES

IX. ASSESSMENT OF ALTERNATIVES

Economic Assessment

Damaging floods have occurred in the subbasin quite frequently. This is due to the natural drainage and topography which is poorly developed for the removal of runoff water. In addition, the main streams have few natural tributaries, which results in broad land areas between the main streams having little or no drainage. According to the Buffalo-Red River Watershed District, these problems have been compounded by the draining and plowing of potholes and sloughs, thus reducing the water retention capabilities of the land surface.

Average annual benefits were derived from either updating average annual benefits from prior reports to October 1979 levels, or applying updated weighted damage per acre figures from the Phase 1, General Design Memorandum for Flood Control and Related Purposes, Sheyenne River, North Dakota.

The economic evaluation of the eight proposed flood control alternatives indicated that only alternatives 2 and 7 had benefit/cost ratios high enough to justify implementation. Alternative 2 involved 11 miles of channel improvement to the Buffalo River from the mouth of the South Branch to U.S. Highway 10 near Stockwood. The channel would be modified to contain a 30 percent (three-year) frequency flood and would provide protection for about 3,300 acres of farmland. Economic analysis of this alternative yielded a benefit/cost ratio of 2.74. Alternative 7 involves the construction of levees around individual farmsteads located in flood-prone areas. Economic analysis of this alternative yielded a benefit/cost ratio of 2.10.

Alternative 5 is a measure proposed by the Soil Conservation Service (SCS). Average annual benefits used in the analysis presented in Table 19 included only primary benefits that most nearly comply with Corps of Engineers criteria. The SCS also developed figures that included secondary benefits. With these secondary benefits, the B/C ratio would be 1.03.

Table 19

ECONOMIC EVALUATION OF ALTERNATIVES, BUFFALO RIVER SUBBASIN

Alternative	Acres Protected	Average Annual Acres	Capital Costs	Average Annual Costs	Average Annual Rural Benefits	Average Annual Urban Benefits	Total Average Annual Benefits	b/c Ratio
Channel Improvements (10% flood)	9,900	2,319	$5,644,000	$ 415,500	$197,800	--	$197,800	0.48
Channel Improvements (30% flood)	3,300	954	404,000	29,700	81,400	--	81,400	2.74
Agricultural Levees (1% flood)	14,800	571	6,425,000	472,900	48,700	--	48,700	0.10
Urban Levees (1% flood protection at Barnesville)	--	--	1,171,000	86,200	--	$7,600	7,600	0.09
Upstream Reservoirs (channel improvements, and land treatment programs)	110,500	--	5,691,000	418,900	300,300	--	300,300	0.72
Upstream Reservoir (51,000 acre-feet capacity)	3,100	702	18,371,000	1,352,300	59,900	--	59,900	0.04
Farmstead Levees (per levee)	--	--	5,600	400	840	--	840	2.10
Channel Improvements (snagging, clearing and cutoffs)	--	--	2,868,000	211,100	125,600	--	125,600	0.59

Source: Gulf South Research Institute.

Impact Assessment

Table 20 provides a generalized assessment of anticipated impacts on various key resource elements of the subbasin resulting from each of the eight structural measures being considered. The rationale used in developing the ratings is presented below.

Channel Improvements

Several alternative channel improvement measures on the Buffalo River and its tributaries are recommended for further consideration. All would yield moderately beneficial social and economic effects, adverse biological effects, and short-term adverse but long-term beneficial results for water quality elements. No known effects would take place with respect to water supply, cultural resources, and recreation.

Social and economic benefits would accrue from the flood protection and flooding reductions that would stem from the channel improvement projects. Some 3,000 to 9,000 acres would be afforded such benefits, depending on the alternative selected. Biological and water quality elements would be minimally to moderately adversely affected by dredging activities, vegetation removal, and temporary turbidity.

Agricultural Levees

The proposed agricultural levees would provide protection against a 100-year frequency flood for some 14,800 acres and are thus deemed to be moderately beneficial from social and economic standpoints. Vegetation communities would be protected and habitats would be expanded or created in association with the levee setbacks. Temporary turbidity would minimally adversely affect water quality. It is not known how water supply and cultural elements would be effected.

Urban Levees-Barnesville

Prevention of flood damages at Barnesville would result in moderately beneficial social and economic effects to the community and subbasin. In the summer of 1975, the town sustained over $400,000 in damages from an overflow of Whiskey Creek. These beneficial effects include the reduction or prevention of damages to and/or loss of personal property, the potential for disruptions in the delivery of emergency services, drains or community

Table 20

ASSESSMENT OF MEASURES, BY RESOURCE ELEMENT, BUFFALO RIVER SUBBASIN

Measures	Social	Economic	Land Use	Biology	Water Quality	Water Supply	Cultural	Recreation
Channel Improvements (10% flood)	MoB	MoB	NKE	MaA	MiA/B	NKE	NKE	NKE
Channel Improvements (30% flood)	MoB	MoB	NKE	MoA	MiA/B	NKE	NKE	NKE
Agricultural Levees (1% flood)	MoB	MoB	NKE	MoB	MiA	NKE	NKE	MiB
Urban Levees (Barnesville)	MiB	MiB	NKE	MiA	NKE	NKE	NKE	NKE
Reservoirs (5), channel improvements, and land treatment	MaB	MaB	MiA	MoA	MiB	NKE	NKE	NKE
Reservoir (51,000 Acre-Feet)	MiB	MiB	MiA	MoA	NKE	NKE	NKE	MiB
Farmstead Levees (per levee)	MiB	MiB	NKE	NKE	NKE	NKE	NKE	NKE
Channel Improvements (snagging, clearing and cutoffs)	MiB	MiB	NKE	MoA	MiA/B	NKE	NKE	NKE

Note: **NKE No-Known Effect**

MiA-Minimally Adverse	MiB-Minimally Beneficial
MoA-Moderately Adverse	MoB-Moderately Beneficial
MaA-Maximally Adverse	MaB-Maximally Beneficial

Source: Gulf South Research Institute.

services, temporary or permanent loss of community facilities, loss of community tax base and losses in personal income. In addition, such measures would serve to reduce many of the negative behavioral consequences associated with flooding problems. No known effects would take place by land use, water quality and supply, cultural elements, and recreational elements.

Minimally adverse environmental and biological impacts would accrue as a result of project construction. Some streamside floodplain vegetation would be destroyed by project construction, and there would be minor degradation in aesthetic qualities and temporary air and noise pollution.

Upstream Reservoirs (5), Channel Improvements and Land Treatment

Three floodwater retarding structures and two multipurpose (flood prevention and wildlife) structures containing a total planned capacity of 9,300 acre-feet of storage are recommended for further investigation, along with some 39 miles of channel improvements on Hay Creek, Stony Creek, and Whiskey Creek and land treatment for 26,000 acres.

These measures, when combined, would afford flood protection to over 110,000 acres, 400 farmsteads, and nearly 2000 persons, including the towns of Baker, Barnesville, and Downer. Maximum beneficial economic and social benefits would thus result from such measures. Net environmental effects cannot be determined precisely, although it can be stated that moderately adverse effects on biological elements would take place with the construction of the five impoundments and the channel improvements. However there would be some beneficial biological effects from the impoundments. Land treatment of some 26,000 acres is viewed as moderately beneficial, since it would improve water quality (reduction in turbidities associated with wind and water) and might have beneficial effects on wildlife stemming from the establishment of greenbelts. It is not known what effects would be experienced by water supply and cultural and recreation elements.

Economic

An upstream impoundment with a total storage capacity of 51,000 acre-feet would have minimally beneficial social and economic effects. The benefits would accrue mostly from protecting some 3,100 acres from flooding. Recreation would be beneficially, although minimally, affected.

Minimally adverse effects would be experienced by land use elements as a result of changes in use and development, while moderately adverse results would be experienced by biological elements, largely due to the disruptions and changes in the existing habitat. No or negligible effects would take place for water quality and supply and cultural elements.

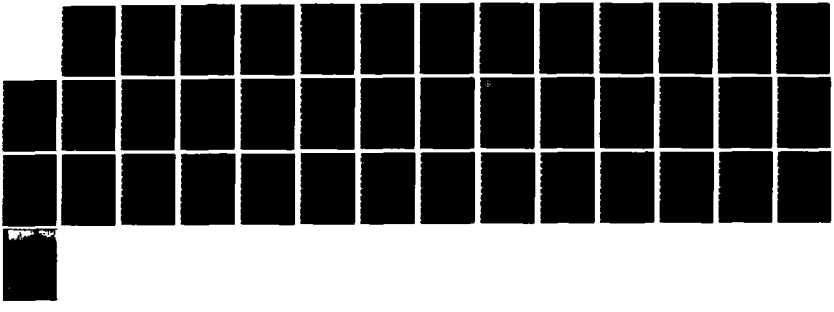
Farmstead Levees

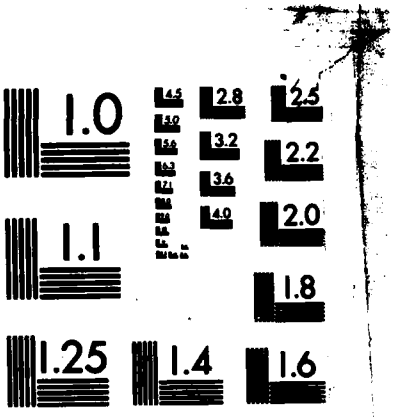
Minimally beneficial economic and social effects would result from the protection of numerous farmsteads in the 100-year floodplain. The other resource elements, excepting aesthetics and possibly public health, would not be affected.

X. EVALUATION

AD-A140 788 RED RIVER OF THE NORTH RECONNAISSANCE REPORT: BUFFALO RIVER SUBBASIN(U) GULF SOUTH RESEARCH INST BATON ROUGE LA DEC 80 DACW37-80-C-0017 2/2

UNCLASSIFIED F/G 8/8 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

X. EVALUATION

Only two of the eight measures analyzed for the subbasin have benefit/cost ratios that exceed unity. They are: (1) channel improvements of 11 miles of the Buffalo River from the mouth of the South Branch to U.S. Highway 10 near Stockwood; and (2) the farmstead levees.

Both of the measures would have favorable social well-being effects, although to a considerably lesser extent than several of the alternatives which did not surpass the unity criteria. Net economic benefits are maximized with the 11-mile Buffalo River channel improvements. Although the farmstead ring levees also exceed the above unity measurement, they do not notably benefit the resolution of subbasin flooding problems.

Great environmental enhancement would result from the agricultural levees associated with protecting 14,800 acres, since protection would be afforded to the riparian belt and would create or expand habitats associated with levee setbacks.

National Economic Development (NED) and Environmental Quality (EQ) plans will be tentatively formulated in association with the Red River of the North Basin main reconnaissance report.

XI. ADDITIONAL STUDY NEEDS

XI. ADDITIONAL STUDY NEEDS

This report was developed almost entirely on the basis of secondary information from readily available planning documents. Data available from state and Federal agencies was not fully canvassed, and only a limited number of calls were made to the area. In particular, state university libraries and department resources could not be fully utilized. Thus, the document aims only at a broad-brush perspective. In order to provide a more detailed and in-depth analysis of subbasin resources, problems, and potential solutions, the following additional study needs would have to be fulfilled:

1. A literature search should be conducted to obtain available biological data for the subbasin. Fieldwork should be planned to fill in any data gaps which exist with the end result of obtaining good baseline data for the subbasin. This is particularly necessary in those areas where flood-control measures have been proposed.
2. Areas of high environmental quality (e.g., prairie remnants) should be identified and inventoried within the subbasin.
3. Knowledge of the location, areal extent, and types of wetlands occurring within the specific subbasin boundaries would be extremely useful in determining whether wetland restoration would assist in solving flooding problems, as has been indicated by Cernohous (1979).
4. Primary water and sediment quality data are needed to characterize baseline conditions in the streams of the subbasin in those areas where channel modifications are proposed.
5. Information on wastewater management needs to be updated.
6. The information obtained in items 1-5 above would provide an important data base upon which the cumulative impacts of flood control projects on environmental resources can be conducted. These projects include those that are in-place, in the construction phase, and either authorized or planned for the subbasin.
7. The potentiality for land treatment measures (e.g., erosion control measures such as cover crops, green belts, reduction in fall tillage, etc.) need to be thoroughly investigated.
8. More gauging stations need to be developed to provide hydrologic data for establishing flood frequencies and rating curves.
9. Channel cross-sections of the various streams need to be prepared for flood control planning purposes.

10. The people of the subbasin need to be included in further water resource planning efforts. A public involvement program would provide more complete information on water resource problems and opportunities than is presently available.

11. Studies are needed to determine additional demand for recreational facilities, usage of existing facilities, and potential sites.

12. A review of secondary sources and systematic field reconnaissance is needed to identify archaeological and historical sites.

13. A detailed social profile of the subbasin is needed.

14. A detailed institutional analysis of the subbasin is needed.

15. Subbasin boundaries need to be better defined on the basis of hydrologic conditions, and total acreage in the subbasin needs to be precisely measured.

16. An adequate 100-year floodplain map needs to be developed. Also, the extent of floodplains for smaller frequency storms needs to be delineated.

17. Land use within the floodplain needs to be precisely identified.

18. The irrigation potentials of the subbasin soils needs to be investigated.

19. The effect of drainage works on flood discharges and stages is unknown at present. It would take additional, more detailed studies to determine the extent and effect of reduced natural storage.

20. Potentialities for floodwater storage in present drainage ditches needs to be investigated.

21. Crop distribution in the floodplain needs to be precisely identified through contact with county agents, and average annual rural damages need to be updated.

22. Urban damages need to be recomputed in a systematic fashion.

23. Consideration should be given to combining the Buffalo-Red Watershed District with the Lower River Water Management Board.

BIBLIOGRAPHY

BIBLIOGRAPHY

Blegen, Theodore C. 1963. Minnesota: A History of the State. University of Minnesota Press, Minneapolis, MN. 688 pp.

Borchert, John R. 1970. Minnesota Settlement and Land Use-1985. Minnesota State Planning Agency, St. Paul, MN. 43 pp.

_____. 1974. Perspective on Minnesota Land Use-1974. Minnesota State Planning Agency, St. Paul, MN. 56 pp.

Bureau of the Census. 1977. Census of Retail Trade for Minnesota. U. S. Department of Commerce, Washington, D. C.

_____. 1977. Census of Selected Services. U. S. Department of Commerce, Washington, D. C.

_____. 1977. Census of Wholesale Trade for Minnesota. U. S. Department of Commerce, Washington, D. C.

_____. 1972. County and City Data Book. U. S. Department of Commerce, Washington, D. C.

_____. 1979. Population Estimates and Projections, Series P-25 and P-26, No. 78-23 and No. 836. U. S. Department of Commerce, Washington, D. C.

Bureau of Economic Analysis. 1979. Survey of Current Business. Vol. 59, No. 4 (April, 1979). U. S. Department of Commerce, Washington, D. C.

Bureau of Environmental Planning and Protection. 1979. Minnesota State Comprehensive Outdoor Recreation Plan (Draft). Minnesota Department of Natural Resources: St. Paul, MN.

Bureau of Lands. 1977. Wildlife Management Areas. Minnesota Department of Natural Resources: St. Paul, MN. 29 pp.

Cernohous, L. 1979. The Value of Wetlands for Flood Control. U. S. Fish and Wildlife Service, Bismarck Area Office, Bismarck, ND. 7 pp.

Conant, R. 1975. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. Houghton Mifflin Company, Boston. 429 pp.

Cvancara, A. M. 1970. "Mussels (Unionidae) of the Red River Valley in North Dakota and Minnesota, U. S. A.", Malacologia. 10(1):57-92.

Division of Parks and Recreation. 1980. SCORP Maps - Becker County, Clay County, Ottertail County, and Wilkin County. Department of Natural Resources: St. Paul, MN.

Henderson, C. 1978a. Minnesota Breeding Birds: Relative Abundance and Distribution. Minnesota Department of Natural Resources, St. Paul, MN. 33 pp.

Henderson, C. 1978b. An Inventory of Colonial Water Bird Nesting Sites in Minnesota. Appendix. Minnesota Department of Natural Resources, St. Paul, MN. 20 pp.

_____. 1979. Guide to the Reptiles and Amphibians of Northwest Minnesota - Region 1S. Minnesota Department of Natural Resources, St. Paul, MN. 5 pp.

_____. 1979c. A Preliminary Review of the Taxonomy, Distribution, Legal Status, and Utilization of Non-Game Mammals in Minnesota. Minnesota Department of Natural Resources, St. Paul, MN. 27 pp.

_____, and J. Reitter. 1979. Guide to the Non-Game Mammals of Northwest Minnesota, Region 1S. Minnesota Department of Natural Resources, St. Paul, MN. 6 pp.

Johnson, Elden. 1962. "The Prehistory of the Red River Valley", Minnesota History. 38(4):157-165.

Maclay, R. W., L. E. Bidwell, and T. C. Winter. 1969. Water Resources of the Buffalo River Watershed, West-Central Minnesota. U. S. Geological Survey, Hydrologic Investigations Atlas HA-307.

Mann, G. E. 1979. Major Minnesota Wetland Zones. Bureau of Planning and Research, Minnesota Department of Natural Resources, St. Paul, MN.

McCabe, T. L., and R. L. Post. 1977. Skippers (Hesperioidea) of North Dakota. North Dakota Insects Publication No. 11, Schafer-Post Series, North Dakota State University, Fargo. 70 pp.

Michlovic, Michael G. 1978. An Archaeological Survey of Clay County, Minnesota. A report submitted to the Minnesota Historical Society, St. Paul, MN. 71 pp. plus Appendices and Figures.

Miles, Catherine H. and Donald P. Yaeger. 1979. Minnesota Outdoor Atlas: A Guide to State and National Recreation Lands in Minnesota. 232 pp.

Minnesota Department of Agriculture. 1979. Minnesota Agricultural Statistics. Minnesota Department of Agriculture, St. Paul, MN.

Minnesota Department of Economic Development. 1979. Minnesota Directory of Manufacturers, 1979-1980. Minnesota Department of Economic Development, St. Paul, MN.

Minnesota Department of Economic Security. 1979. Labor Force Estimates, 1970-1978. Minnesota Department of Economic Security, St. Paul, MN.

Minnesota Department of Transportation. 1978. Minnesota Aeronautical Chart. Minnesota Department of Transportation, St. Paul, MN.

_____. 1979. Minnesota Airport Directory. Minnesota Department of Transportation, St. Paul, MN.

_____. 1979. Minnesota Railroad Map. Minnesota Department of Transportation, St. Paul, MN.

Minnesota Pollution Control Agency. 1975. Red River of the North Basin Water Quality Management Basin Plan. Division of Water Quality, St. Paul.

_____. 1979. Agriculture Package 1, 208 Water Quality Management Planning. Division of Water Quality, Planning Section, St. Paul, MN. 468 pp.

Minnesota Soil Conservation Service. 1979. Minnesota Watershed - River Basin Status Report, October 1979. Minnesota Soil Conservation Service, St. Paul, MN. 34 pp.

Minnesota State Planning Agency. 1979. Climate Zones, Minnesota State Planning Agency, St. Paul, MN. (Map).

_____. 1978. Minnesota's Land Use Planning Process. Minnesota State Planning Agency, St. Paul, MN. 128 pp.

_____. 1978. Population Estimates for Minnesota Counties. Minnesota State Planning Agency, St. Paul, MN.

"Minnesota's Transportation Network". Minnesota Economic Development News, Vol. 6, No. 3, March 1979.

Minnesota Water Resources Board. 1979. Overall Plan: Buffalo-Red River Watershed District. St. Paul, MN. 85 pp.

Moyle, J. B. 1974. Minnesota Animals and Plants in Need of Special Consideration, with Suggestions for Management. *Minnesota Department* of Natural Resources, Division of Fish and Wildlife. Special Publication No. 104. 26 pp.

National Wetlands Technical Council. 1978. Scientists' Report. National Symposium on Wetlands. 129 pp.

The Nature Conservancy. No date. Minnesota's Preserved Tracts and Their Use. Minnesota Chapter. 6 pp. (mimeo.).

North Central Forest Experiment Station and Minnesota State Planning Agency. No date. Major Forest Types - Minnesota 1977 Inventory U. S. Forest Service and Minnesota Land Management Information Center, St. Paul, MN. Map.

Peterson, A. R. 1971. Fish and Game Lake Resources in Minnesota. Minnesota Department of Natural Resources, Division of Game and Fish, Section of Technical Services, Special Publication 89. 51 pp.

Saylor, Stanley. 1975. "DhLb-1: Early Period Occupation near Glacial Lake Agassiz, Southeastern Manitoba", Plains Anthropologist. 20(70):241-252.

Souris-Red-Rainy River Basins Commission. 1972. Souris-Red-Rainy River *Basins Comprehensive Study. Souris-Red-Rainy* River Basins Commission, Moorhead, MN. 8 vols.

Strong, William D. 1941. "From History to Prehistory in the Great Northern Plains", Smithsonian Miscellaneous Collections. 100:353-394.

St. Paul District Corps of Engineers. 1979. The Development of Nonstructural Alternatives. St. Paul District Corps of Engineers, St. Paul, MN. 83 pp.

_____. 1975. Mississippi, Souris, Red River Basin Post Flood Report, 1975. St. Paul District Corps of Engineers, St. Paul, MN. 90 pp.

_____. 1973. Red River of the North Basin Plan of Study. St. Paul District Corps of Engineers, St. Paul, MN. 224 pp.

_____. 1979. Red River of the North and Souris River Post Flood Report, 1979. St. Paul District Corps of Engineers, St. Paul, MN. 100 pp.

_____. 1979. Flooding on the Red River of the North and Its Tributaries. St. Paul District Corps of Engineers, St. Paul, MN.

University of Minnesota, Department of Soil Service in Cooperation with Minnesota Geological Survey and U. S. Soil Conservation Service. 1978. Soil Landscapes and Geomorphic Regions - Brainerd Sheet. (Map).

U. S. Environmental Protection Agency. 1976. Quality Criteria For Water. Washington, D.C. 501 pp.

U. S. Fish and Wildlife Service. 1979a. Aquatic Resources Package for Minnesota Tributaries to the Red River of the North. Ecological Service Office, St. Paul, MN.

_____. 1979b. Species Accounts for Threatened and Endangered Species in the Great Lakes Region. Regional Office, Twin Cities, MN.

_____. 1980. Terrestrial Resources Package for Minnesota Tributaries to the Red River of the North. Ecological Services Office, St. Paul.

U. S. Geological Survey. 1979. Water Resources Data for Minnesota: Volume 1. Great Lakes and Souris-Red-Rainy River Basins. U. S. Geological Survey Water - Data Report MN-78-1, Water Year 1978. 300 pp.

Upper Mississippi River Basin Commission. 1977. 1975 National Water Assessment, Specific Problem Analysis Report, Vols. 1 and 2, Upper Mississippi and Souris-Red-Rainy River Regions. Upper Mississippi River Basin Commission, Twin Cities, MN.

Wanek, W. J. 1967. The Gallery Forest Vegetation of the Red River of the North. M. S. Thesis, North Dakota State University, Fargo, ND. 211 pp.

Water Management Group. 1979. (Draft) Management Problems and Alternate Solutions: Technical Paper No. 14. Minnesota Water Planning Board: St. Paul, MN. 149 pp.

West Central Regional Development Commission. 1979. Annual Overall Economic Development Program Report. West Central Regional Development Commission, Fergus Falls, MN. 200 pp.

Appendix A
FLOODPLAIN DELINEATION

Appendix A
FLOODPLAIN DELINEATION

Prior to this study, no attempt was made to publish even a generalized delineation of the entire Buffalo River floodplain. In undertaking this task, the present study utilized all known sources to provide the best available data for generalized delineation at a scale of 1:250,000. Principal sources were: USGS Flood Prone Area Maps (scale 1:24,000), Federal Insurance Administration flood maps (various scales), published secondary sources, U.S. Geological Survey (USGS) 7 1/2 minute topographic maps, and other sources, including derived data where necessary.

In terms of the availability of data, the subbasin is fairly representative of Red River subbasins in Minnesota. The Flood-Prone Area Maps published by the USGS provided detailed and accurate information for the area mapped. For the subbasin, however, only one 7 1/2 minute sheet in the Main Stem Red River area (northeast of Moorhead) was available.

Federal Insurance Administration Flood Hazard Boundary Maps and Flood Insurance Rate Maps provide important coverage of the Minnesota portion of the Red River Basin. The former are designed only to delineate the 100-year floodplain. The latter are much more detailed and usually more accurate. Clay and Wilkin counties, comprising 60 percent of the basin, have detailed flood rate maps. Flood hazard maps were utilized for the portions located in Becker and Ottertail counties.

Secondary sources, such as the Souris-Red-Rainy River Basins Type II Study (delineating the Main Stem floodplain) were also utilized. Published floodplain descriptions and acreage estimates in the Soil Conservation Service South of Hawley-South Buffalo Watershed Work Plan and other sources were consulted. U.S. Geological Survey 7 1/2 minute topographic maps of relevant areas included six complete sheets scattered throughout the subbasin and parts of two more in the lower Buffalo-Main Stem Red River area. These maps proved particularly useful in verifying marsh locations and extent.

As noted earlier, data from the above sources was compiled and delineated on USGS 250,000-scale maps. The floodplain indicated was then planimetered by segment, and figures in square inches were converted to land measure and rounded to the nearest 2,000 acres.

Appendix B

INVENTORY OF OUTDOOR RECREATIONAL FACILITIES (WILDLIFE MANAGEMENT AREAS) BUFFALO RIVER SUBBASIN

Appendix B

INVENTORY OF OUTDOOR RECREATIONAL FACILITIES (WILDLIFE MANAGEMENT AREAS)
BUFFALO RIVER SUBBASIN

Number	Name	Location	Boundary Acres	WMA Managed Acres	Date[1]
1	Jeral WMA	Clay Co. 14045W05 Clay Co. Game Refuge	74.3	74.3	71
2	Cromwell WMA	Clay Co. 14045W01 Solwald Lake	278.1	278.0	71
3	Hitterdal WMA	Clay Co. 14044W16 Hitterdal	267.7	261.0	71
4	Highland Grove WMA	Clay Co. 14044W22 Hawley	160.0	80.0	71
5	Gruhl WMA	Clay Co. 14045W32 Clay Co. Game Refuge	307.7	307.0	71
6	Hawley WMA	Clay Co. 13945W35 Doran Lake	477.0	160.0	71
7	Magnusson WMA	Clay Co. 13845W07 Rushteldt Lake	344.1	264.0	71
8	Bjornson WMA	Clay Co. 13845W24 Rushteldt Lake	1,141.4	560.0	71
9	Clay Co. WMA	Clay Co. 13845W22 Skree Township	358.0	320.0	71
10	Skree WMA	Clay Co. 13845W24 Purke Township	178.7	162.0	71
11	Hay Creek WMA	Clay Co. 13845W26 Skree Township	160.0	40.0	71
12	Janssen WMA	Clay Co. 13845W34 Skree Township	160.0	160.0	71

Appendix B (Cont'd)

INVENTORY OF OUTDOOR RECREATIONAL FACILITIES (WILDLIFE MANAGEMENT AREAS)
BUFFALO RIVER SUBBASIN

Number	Name	Location	Boundary Acres	WMA Managed Acres	Date[1]
13	Barnsville WMA	Clay Co. 13845W36 Barnsville	2,375.0	741.0	71
14	I-94 Borrow Pit WMA	Clay Co. 13746W13 Barnesville	88.3	88.0	71
15	Riparia WMA	Becker Co. 14142W15 Trotter Chand Lake	40.0		71
16	Cuba WMA	Becker Co. 14043W27 Stinking Lake	88.2	88.0	71
17	Lunde WMA	Becker Co. 13943W09 Sand Lake	50.9	51.0	71
18	Audubon WMA	Becker Co. 14042W33 Torgerson Lake	29.2	29.0	71
19	Callaway WMA	Becker Co. 14141W26 Callaway	321.5	321.0	71
20	Richwood WMA	Becker Co. 14041W14 Touson Lake	40.5		71
21	Atherton WMA	Wilkin Co. 13646W35	545.0	440.0	71
22	Manston WMA	Wilkin Co. 13546W30	400.0	76.0	71
23	Rothsay WMA	Wilkin Co. 13545W28	4,300.0	2,946.0	71
		Total Acres:	12,185.6	7,446.3	

[1]Date of latest information.

Source: Department of Natural Resources, Division of Parks and Recreation.

Appendix B

INVENTORY OF OUTDOOR RECREATIONAL FAC
BUFFALO RIVER SUBBASIN

Number	Name	Ownership	Administration	Location	Boundary Acres	Number of Resort Units	Campground: Primitive	Campground: Modern	Campground: Group	Wildlife Management Acres	Athletic Field Acres	Golf
1	Big Sugar Bush Resort	Private		Becker Co. 14140W08 Big Sugar Bush Lake	143.0	4		4				
2	Hawley Municipal Park	Municipal		Clay Co. 13945W12 Hawley	20.0							
3	North Dakota Retriever Club	Private		Clay Co. 13947W09 Glyndon	93.0							
4	Buffalo River State Park	State	DNR[6]	Clay Co. 13946W14 Riverton Township	12,400.0							
5	Granrud Farm Campground	Private		Clay Co. 13844W15 Lake Fifteen	16.0		5	5				
6	Blue Eagle Lake Municipal Park	Municipal		Clay Co. 13745W30 Blue Eagle Lake	35.0						7	
7	Barnesville Elementary School Athletic Field	School		Clay Co. 13745W30 Barnesville	16.0						16	
8	Western Prairie Science and State Nature Area	State	DNR	Wilkin Co. 13546W12 Deerhorn Creek	600.0							
1	Hawley Municipal Golf Course	Municipal		Clay Co. 13945W12 Hawley	73.0							18
2	Royal Oak Snow Ski	Private		Clay Co. 13844W24 Lake Thirteen	60.0							
3	Willow Creek Golf Course	Private		Clay Co. 13745W27 Barnesville	72.0							9

[1]Facilities included are limited to those with 15 or more acres.

[2]Boat rental.

[3]Boat storage.

[4]Parking spaces.

[5]Date of latest information.

[6]Department of Natural Resources.

Source: Department of Natural Resources, Division of Parks and Recreation.

B

ATIONAL FACILITIES[1]
UBBASIN

Athletic Field Area	Golf	Marina: Canoe	Marina: Rental[2]	Marina: Storage[3]	Playground	Park[4]	Ramp	Picnic Table	Beach	Pool	Trails (Miles): Nature	Trails (Miles): Horse	Trails (Miles): Snow	Trails (Miles): Hike	Trails (Miles): Bike	Trails (Miles): Ski	Trout	Shooting Range	Rest Area	Fairground	Data[5]
			X		X				X				1								76
					X			20	X												76
																					76
								70	X		X				7						76
			X					8	X												76
7					X			16	X												75
16					X																75
								1											X		75
	18																				76
																					76
	9																				77

Appendix C
COMMENTS

Appendix C
COMMENTS

The purpose of this subbasin report was to provide an overview of the water and related resource problems and needs and to assess potential solutions. Toward this end, draft copies of this report were circulated to Federal, State, and local agencies and comments were sought.

This review resulted in complete and factual documentation. Thus, the study should serve as a building block for the timely completion of future water resource efforts within the subbasin. Further cooperative efforts are, however, needed to evaluate these tentative results and to develop potential solutions.

A distribution list and copies of the comments made with respect to the draft report are included as part of this appendix. Comments that resulted in specific modifications to the draft text are marked by an asterisk.

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
1135 U S POST OFFICE & CUSTOM HOUSE
ST PAUL, MINNESOTA 55101

REPLY TO
ATTENTION OF:

NCSED-PB

21 July 1980

Mr. Mike Liffmann
Project Manager
Gulf South Research Institute
8000 GSRI Avenue
Baton Rouge, Louisiana 70808

Dear Mr. Liffmann:

The draft Buffalo River subbasin report was distributed for review and comment. Most of the reviewers have sent their comments to us.

a. Inclosure 1 includes letters from various Federal and State agencies.

b. Inclosure 2 is the general office comments that need to be considered when preparing the final Buffalo River subbasin report and the remaining subbasin reports.

c. Inclosure 3 identifies specific office concerns that are applicable to the Buffalo River subbasin report.

If you have any questions on our comments or proposed modifications, please contact us.

Sincerely,

Louis E Kowalski

LOUIS E. KOWALSKI
Chief, Planning Branch
Engineering Division

3 Incl
As stated

United States Department of Agriculture
Soil Conservation Service
316 North Robert St., Room 200
St. Paul, Minnesota
55101

SUBJECT: 150-13 DAP, Red River of the North DATE: June 16, 1980

William W. Badger, Colonel
Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

We have reviewed the Wild Rice-Marsh Rivers and Buffalo River Subbasin Draft Reports for the Red River of the North Reconnaissance Study being conducted under contract by the St. Paul District, U. S. Army Corps of Engineers. The following comments are provided for your consideration:

Wild Rice - Marsh Rivers Subbasin

1. The highway designations on the maps on pages 6, 11, 41, 50, 64, and 69, appear to be in disagreement with standard highway map designations. It appears that Highway 31 going through Ada should be designated Highway 200 and Highway 31 going north and south on the east side of the watershed should be designated as Highway 92.

2. The second sentence on page 8 needs to be reworded for clarity.

3. In the last paragraph on page 12, it is suggested that the first sentence in that paragraph be reworded as follows:

   "Present average annual damages are estimated at $2,115,000."

4. The discussion on page 13 comparing the 1979 flood event with the average annual urban flood damages should be reviewed for accuracy. It does not seem realistic for damages for one large event to be less than the average annual figures. If that discussion is in error, changes should also be made in Table 1 on page 14.

5. The first sentence in paragraph 3 on page 23 needs to be revised for clarity.

6. On page 26, the term "two digit standard industrial classification (SIC)" is used. That term should be defined for the lay reader.

7. On page 31, the second full sentence reads, "Some pheasant (less than one hen per square mile) and sharptailed grouse (1-6 adult males per square mile) probably occur. It appears that when the wording is specific as to the number that occur, the term "probably" should be stricken from the sentence.

8. On page 37, paragraph 4 states that White Earth and Beltrami Island are the only state forests in the Minnesota portion of the Red River Basin. It appears that Buena Vista and Red Lake State Forest also are partially or wholly within the Red River Basin.

9. On page 45, there is a discussion of various types of wetlands. In some cases, the "Type" is designated as a numeral and in other cases the numeral is spelled out. The writer should be consistent in designating the types of wetlands in the basin.

10. The last paragraph on page 65 states that "the adequacy of existing projects was not evaluated during the development of the study because the Corps of Engineers has indicated that present and projected proposed projects should be satisfactory to control the major flood problems in the subbasin." On page 66, the prime objectives are stated as, "The primary planning objectives of this study was to contribute to flood reduction needs in the subbasin and thereby provide protection from or reduction of flood lawsuits." If those statements are true, this study is not necessary.

11. On page 71 in the second paragraph, it is suggested that the second sentence be modified to read, "The weighted average crop damage per acre flooded and other agricultural flood damages per acre multiplied by the average annual area flooded established total agricultural damages." Key word being average.

12. In Table 18 on page 72, it would be interesting to note how many reservoirs and miles of channel improvement were used to estimate figures in this table. Also, when talking about installation of farmstead [illegible] based on a unit basis or is this for one [illegible].

13. On page 73, second paragraph, second sentence, it is suggested that the term average annual flood protection be used in place of average annual flood control.

Buffalo River Subbasin

1. The highway designation on the map on pages 4, 8, 39, 47, 49 and 63 show Highway 82 in the southern portion of the watershed. This designation should be changed to Highway 9.

*2. In the third paragraph, page 57, it is suggested that starting with the third sentence, it read as follows:

"The SCS developed a plan for flood prevention and wildlife protection for the South of Hawley-South Buffalo Watershed. Planning assistance, however, has been suspended on this watershed. A preliminary investigation was also completed on the Deerhorn-Buffalo Watershed. Planning assistance was terminated on this project also."

*3. In the second paragraph, on page 59, other types of measures for flood damage reduction are discussed. It should be clarified that the measures listed would only provide a small degree of flood damage reduction. The use of drainage ditches for flood water storage is questionable since this is contrary to the perceived purpose of efficient water removal. The installation of land treatment measures is voluntary and entirely up to the individual landowner.

There are numerous typographical errors detected throughout the report. It is suggested that a complete editorial review be provided prior to submitting this report to the public.

We appreciate the opportunity for reviewing this report. I hope these comments will be beneficial in completing this study in the Red River of the North.

Jon V. DeGroot
Assistant State Conservationist

cc: Ivan R. Wilkinson, RB&WSP Leader, SCS, St. Paul

USDA:SCS:IRWilkinson:WPC:jla:6/16/80

United States Department of the Interior

FISH AND WILDLIFE SERVICE

IN REPLY REFER TO:

St. Paul Field Office, Ecological Services
538 Federal Building and U.S. Court House
316 North Robert Street
St. Paul, Minnesota 55101

June 27, 1980

Colonel William W. Badger
Dist. Engineer, St. Paul Dist.
U.S. Army Corps of Engineers
1135 U.S. Post Office
St. Paul, MN 55101

Dear Colonel Badger:

This provides U.S. Fish and Wildlife Service comments on the Draft Reconnaissance Report recently compiled by Gulf South Research Institute for the Buffalo River Subbasin in Becker, Ottertail, Clay, and Wilkin Counties, Minnesota.

As expressed in our comments on previous Subbasin Reports, our major concerns are associated with the woodland, grassland, wetland, riverine, and riparian floodplain habitats that still remain within the Buffalo River Subbasin. Much of the native grassland, woodland, and wetland habitat in the western one-third of the Subbasin has been converted to agricultural uses. Remaining grassland and woodland habitat in this area is primarily restricted to along the Buffalo River and other tributary streams, and these habitat types should be preserved within the Subbasin. Remaining wetlands are primarily located in the upland morainal area within the eastern two-thirds of the Subbasin. We agree with the statements on pages 67 and 68 of the Report that the flooding problems in the Subbasin have been compounded by the drainage of wetlands (which has reduced the water retention capabilities of the land surface) and that these natural water retention areas should be preserved and restored.

Wind and water erosion is also a significant problem, particularly in the western part of the Subbasin, and we agree that land treatment measures need to be implemented to retain the water and soil on the land and retard runoff and silt deposition in lakes and streams within the Subbasin.

The Report addressed eight structural alternative measures that have been considered to date to reduce the flooding problems within the Subbasin. The Report indicated, however, that only two of these measures (farmstead levees and channel improvements on 11 miles of the Buffalo River to contain a 30% frequency flood) had benefit/cost ratios high enough to justify implementation. Our comments relative to these various structural measures (channel improvements, levees, and reservoirs) are similar to those expressed on previous Subbasin Reports. We believe a plan involving a combination of structural and non-structural measures (as proposed in our [illegible] U.S. 1980 letter on the Draft Reconnaissance [illegible] basin) should be implemented. We also believe that additional studies

(particularly numbers 2, 3, 7, 13, and 20 identified on pages 75 and 76 of the Report) need to be undertaken to provide a more detailed and in-depth analysis of existing Subbasin problems and the potential solutions to many of these problems.

In addition, we suggest that the following changes be made in the Final Report:

*1. Page 38, last paragraph, 4th sentence -- change this sentence to read as follows: In addition, there are numerous federal Waterfowl Production Areas within the Subbasin that are open to the public for hunting.

* 2. Page 43, Table 12 -- type the numbers for the various wetland types (1, 3, 4, 5) above the number and acreage columns as was done in Table 13.

* 3. Page 45, Table 14 -- change the title of this table to read as follows: Comparison of 1964 and 1974 wetland inventory data showing the number, acreage, and percent changes for the counties within the Buffalo River Subbasin[a].

* 4. Page 46, 3rd paragraph -- omit the second sentence of this paragraph and change the third sentence to read: The data in Table 14 show that the number and acreage of Types 3, 4, and 5 wetlands were reduced by 6,271 and 4,953, respectively, during the 10-year-period from 1964 to 1974.

*5. Page 46, last paragraph, under the heading Waterfowl Production Areas -- change this paragraph to read: These Waterfowl Production Areas (WPA's) are wetland areas that the U.S. Fish and Wildlife Service (USFWS) has either acquired through fee title or obtained an easement interest on to preserve valuable breeding, nesting, and feeding habitat for migratory waterfowl. These wetland areas are purchased, or an easement interest obtained, with funds received from the sale of Migratory Bird Hunting and Conservation Stamps ("Duck Stamps"). These WPA's are significant because they provide the public with a great variety of wildlife-oriented recreational opportunities as well as providing valuable habitat for migratory waterfowl and many other forms of wildlife. The USFWS is responsible for the compatibility determinations (uses) and the issuance or denial of permits involving these lands. The approximate locations of these WPA's (fee tracts) within the Subbasin are shown in Figure V. Total acreage of these WPA's (fee and easement) within Becker, Clay, Ottertail, and Wilkin Counties, Minnesota are given in Table 15.

*6. Page 48, Table 15 -- remove the cost column which is not necessary in this Report and simply type Fee (Acres) and Easement (Acres) above the appropriate acreage columns. In addition, change the title to read: Acres of federal Waterfowl Production Areas (fee and easement) within the Buffalo River Subbasin.

*7. Page 49, last paragraph, under the heading Threatened or Endangered Species -- [illegible] this paragraph to read: "The bald eagle...

*8. Page 39, Figure V -- Type Fee Tracts in parenthesis after Production Areas in the legend. We have attached a copy of Fig. ing the approximate locations of 12 other WPA's that we believe should be identified by a dot on this map.

*9. Page 59, 2nd paragraph, last sentence -- we suggest this sentence be changed and the following statements be included in this paragraph: Information on natural storage areas and potentialities for increased storage is very limited. Indications are, however, that wetlands play a substantial role in controlling runoff, especially in combination with good land treatment practices. Values on storage have averaged about 12 inches per surface-acre of wetlands and have ranged to four times that amount (Carrohous, 1979). The amount of wetland habitat within the watershed area (or Subbasin) is important: statistical studies indicate that in certain situations if a watershed has 15% of its area in wetlands or lakes, peak floods will be 60-65% lower than they would be in the absence of the wetland/lake area; if wetlands or lakes occupy 30% of the watershed, there will be a further reduction in flood peaks up to about 75 or 80% (Scientists' Report, National Symposium on Wetlands, 1978).

10. Page 69 (Table 19) and Page 71 (Table 20) -- We would suggest that these alternatives be numbered 1-8 and addressed in this order in Part VIII of the Report. (Alternative 1 on page 62 should be Alternative 5; Alternative 2b should be Alternative 8; Alternative 2c should be Alternative 6; Alternative 3 should be Alternative 1; Alternative 4 should be Alternative 2; Alternative 5 should be Alternative 3; and Alternative 6 should be Alternative 4). Alternative 7 on page 66 is correct.

11. Pages 70, 72, and 73 -- The Alternative numbers should be assigned to each of these structural measures (Alternatives 1, 2, and 8 -- Channel Improvements; Alternative 3 -- Agricultural Levees; etc.).

*12. Page 79, Bibliography -- include the following reference on this page:

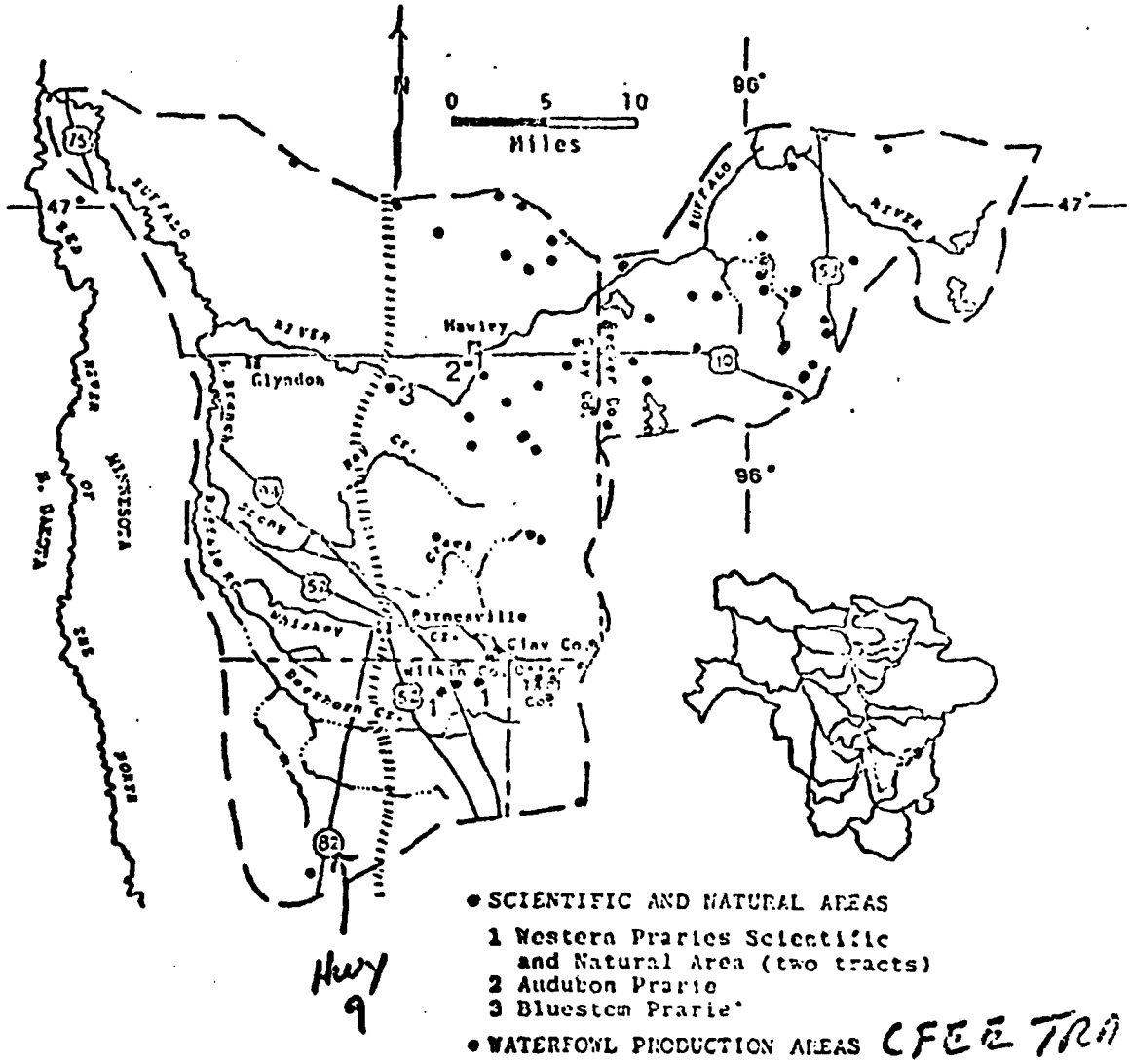
National Wetlands Technical Council. 1978. Scientists' Report. National Symposium on Wetlands. 129 pp.

These comments have been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and are consistent with the intent of the National Environmental Policy Act of 1969.

Sincerely,

Richard F. Berry
Field Office Supervisor

cc: Minn. [illegible]
S. Bittner, Gulf South Res. Inst., New Iberia



Source: The Nature Conservacy (no date); Miles and Yaeger (1979); U.S. Fish and Wildlife Service (1980).

Figure V. WATER FOWL PRODUCTION AREAS AND SCIENTIFIC AND NATURAL AREAS

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
444 Lafayette Road, Space Center Bldg., St. Paul, MN 55101
PHONE 612/296-4800

File No

July 3, 1980

Colonel William W. Badger
St. Paul District
Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Colonel Badger:

COMMENTS ON BUFFALO RIVER AND WILD RICE-MARSH RIVERS SUBBASIN REPORTS

The Department of Natural Resources, Division of Waters has reviewed the above referenced documents. I think that most of the Division's substantive comments have already been made in connection with the other four subbasin reports that have been reviewed to date. I will not repeat these comments and concerns and I hope that the contractor will view those comments as applying to all of the subbasin reports as revisions are made in the documents.

It is apparent after reviewing six subbasin reports that most structural measures will not be economically feasible for construction. It is also apparent that the contractor has not spent very much time looking at very small projects where no Corps participation is possible or at non-structural alternatives such as relocation/aquisition or large scale land treatment programs.

Basically what has been presented in these documents is a reassessment of programs and projects that were proposed over the last twenty years. Most of these projects were not economically feasible when they were proposed and most of them are less economically feasible today.

The Reconnaissance Study was supposed to take an innovative approach to flood damage reduction in the Red River Valley. I realize the constraints of working with secondary data or no data at all, but we are getting very little useful information out of the documents. During the early stages of the study it was hoped that the final report identify a course of action that would reduce a significant amount of the flood damages in the Red River Valley. At this stage it does not appear that this will be the case.

To date, the only conclusion that can be drawn is that there are very few programs and projects that the Corps can participate in under existing authorities. The reports also do not provide enough information for state or local governments or individuals to develop comprehensive flood damage reduction plans.

It may be appropriate to have a meeting to discuss the future revisions to these documents. If the substance of the documents does not change we seriously question the continued expenditure of time and money to this activity at any level. Thank you for the opportunity to comment. If you have questions please contact Joe Gibson at 296-0438 or Ron Harnack at 296-0440.

Sincerely,

DIVISION OF WATERS

Larry Seymour
Director

LS/JG:ph

cc: Joe Gibson
Ron Harnack
Gerald Paul

DEPARTMENT OF THE ARMY
NORTH CENTRAL DIVISION - CORPS OF ENGINEERS
COMMENTS ON
DRAFT BUFFALO RIVER SUBBASIN REPORT
MAY 1980

1. Page 8, Figure II - The map needs a legend that clearly describes the pattern used to delineate the 100-year floodplain, marshy areas, etc.

*2. Pages 58-59 - Modify the explanation of nonstructural measures to incorporate the following concept:

Nonstructural measures lessen the susceptibility of land, people, and property to the impacts of flooding. They do not, however, modify the behavior of floodwaters.

3. Page 60 - Discuss the national objectives (NED and EQ) established by the Principles and Standards.

4. Page 61 - The list of objectives is awkwardly written. Change to read:

Enhance the recreational opportunities in the Buffalo River subbasin for the benefit of the local people.

5. Pages 68-74 - The assessment and evaluation sections need to emphasize how each alternative meets or does not meet the study and national objectives.

6. Page 18 - Holding a public meeting in 1971 does not necessarily mean that the Corps understands the public's needs or that the public understands the Corps' activities.

7. Page 74 - Alternative 5 has an estimated benefit-cost ratio of 0.12 and provides the greatest protection. This should be included in a brief discussion of alternative 5 in the evaluation.

8. Page 76, Additional Studies Needed, #19 - From a hydrologic-hydraulic standpoint, the need for studies to answer this question cannot be overstated. These studies should examine impacts on discharge-frquency relationships caused by levee or channel work.

9. Page 10, Flood Damages - This section should specify which type of flooding - overbank or overland - caused the majority of flood damages. If the floods were caused by rainfall (not snowmelt), the amount of rainfall should be indicated.

10. Page 13, Recreation Problems - Water supply problems of wetlands should be discussed in the preceding section on Environmental Concerns.

11. Pages 6-19, Problem Identification - The report presents a well-documented array of water-related problems. The only shortcoming is that some material is very old and the persistence of the problems at that exact place and magnitude is

questionable. To update the material, local experts and universities should have been consulted and an organized problem identification effort executed as part of the public participation program. The discussion of public perception is questioned because it does not directly cite any public meeting that should have been held prior to this report. If East Grand Forks hearings are the correct meetings, an outline of the findings should be provided.

12. Page 20, Social Characteristics - This section should describe the social environment in terms of trends, quality of life, and specific problems. A good social record of a community are the newspapers. Add no later than Stage II.

13. Page 74, Evaluation - This section should be retitled "Recommendations" and should include a statement to terminate or proceed. The present discussion is not clear. The nonstructural analysis must be carried beyond Stage I.

GENERAL COMMENTS
DRAFT BUFFALO RIVER SUBBASIN REPORT
(MAY 1980)

(These comments apply to the entire report and all subsequent subbasin documents.)

1. This document generally needs additional detailed information concerning nonstructural alternatives. Few of the structural alternatives appear feasible; therefore, unless economics are ignored, nonstructural solutions remain important to reduce the magnitude of future flood damages. The overall report should address and clarify this aspect of flood damage reduction planning.

2. Comments from Federal, State, and local agencies and a letter from the St. Paul District will be included in an appendix in each final subbasin and in the overall report. The format for the appendix will be:

a. Introduction - This section should stress:

(1) The importance of completing the study on time.

(2) That the purpose of the study is to advise other agencies and interests.

(3) The need for a selected review by various interests to provide complete and factual documentation.

(4) The use of the study as a building block for future water resource efforts.

(5) That cooperative efforts to evaluate results and develop solutions to remaining problems will be incorporated.

(6) A complete public involvement program when the study is finished.

b. The distribution list.

c. Copies of letters of comment.

Only comments that identify significant errors or need specific attention will be addressed in the final subbasin report. However, all comments incorporated should be identified with a marking system. The distribution list for the final Buffalo River Subbasin Report is given below:

Agencies receiving draft report	Date sent	Date comments received
Federal		
Soil Conservation Service	30 May 1980	16 Jun 1980
Fish and Wildlife Service	30 May 1980	27 Jun 1980
Corps of Engineers, North Central Div.	30 May 1980	13 Jun 1980
Corps of Engineers, St. Paul District	30 May 1980	9 Jun 1980

State

Water Planning Board	30 May 1980	-
Department of Natural Resources	30 May 1980	3 July 1980
Planning Agency	30 May 1980	-
Water Resources Board	30 May 1980	-

Local

Watershed District	30 May 1980	-
City of Breckenridge	30 May 1980	-
City of Moorhead	30 May 1980	-

3. The source for most information identified in the majority of the tables is Gulf South Research Institute. If other sources were used, an appropriate reference should be made.

4. The evaluation section of each report is primarily the recommendations of the document. Generally only the structural alternatives which have a benefit-cost ratio greater than 1 are presented. Little attention is given to the other structural and nonstructural alternatives that may be an important aspect of future flood damage reduction planning for the subbasin and basin as a whole. Therefore, it is recommended that this section be expanded to provide the appropriate discussions.

5. Rather than stating in each report and for each alternative evaluated that there will be little or no effect on cultural resources, the report should indicate that it is not possible to identify effects on cultural resources until a systematic cultural resources survey has been completed in the subbasin. Such statements are misleading since it appears that there are no significant sites in the subbasin. In reality, there are simply no known sites.

6. The supporting information for alternatives, including technical, economic, and any environmental data, should be provided (at least under separate cover). This would simplify matters when questions are asked during review or in the future.

7. The maps should have more detail. Often information in the text is not clearly illustrated in the maps.

8. Almost all of the subbasin documents identify significant water resource problems (i.e., flooding, water supply, water quality, etc.) throughout the subbasin. However, little if any, reduction in flood damages can be expected from the implementation of the economically feasible alternatives. As a result, the overall document is very important if it is to be valuable to the residents of the basin and if it is to serve as a guide for all Federal and State agencies. This document cannot be a reiteration of the subbasin report. It must clearly and concisely present the following information:

1. The institutional situation as presented in the general comments to the initial report (TOWARD A BASIN PLAN).

2. Cost and agencies involved in satisfying the additional study needs identified in each document. (We will provide costs.)

3. A Red River Basin strategy to be further discussed at a July meeting. (This strategy can be as innovative as necessary but must be a logical conclusion from the initial work accomplished in the basin.)

4. Tentative NED and EQ components.

5. Future interim investigations.

6. Other items considered important.

St. Paul District, Corps of Engineers
Specific Comments
on the
Buffalo River Subbasin Draft Report
(May 1980)

*1. Page 2 - After the last sentence, add: "The main report will consider the possibility of various water resource oriented agencies serving as vehicles for implementing flood damage reduction actions and undertaking additional study needs."

*2. Page 3, last paragraph, 8th line - Change "steam" to "stem."

3. Page 4, Figure I - The following modifications and/or clarifications should be made on this and subsequent maps:

a) Add Georgetown, Stockwood, Kragnes, Sabin, and Rollag all of which are discussed.

b) Change "highway 82" to "highway 9."

c) Identify the escarpment.

*4. Page 7, 1st paragraph, 4th sentence - After "...floodwater" add "and often coincides with that produced by the South Branch."

*5. Page 7, 2nd paragraph, last sentence - It is not clear whether the 3.7 percent contribution of runoff is intended to be a volume or a peak reference. This should be clarified.

*6. Page 7, Location and Extent Section - The second sentence is not correct. While the U.S. Geological Survey maps of flood prone areas do not extend far enough upstream and the flood insurance maps are not complete, both do generally delineate a flood prone area of the Buffalo River subbasin.

7. Page 8, Figure II - The 100-year floodplain outline is generally sufficient for report purposes. For identification of the flood prone areas listed on page 9, it is assumed that a more detailed map was used. Please provide us with this map when the study is completed. Also, add Manitoba Junction to the map to clarify the following floodplain delineation discussions.

*8. Page 9, paragraphs 1 and 4 - It appears in paragraph 1 that the lower Buffalo River floodplain inundates 8,000 acres. In paragraph 4, it suggests that it inundates 22,000 acres below the confluence with the South Branch. These numbers should be modified to agree.

*9. Page 12, 2nd paragraph, line 6 - The subbasin is listed as having "713,960 acres." On page 3 it states the subbasin consists of "760,000 acres." Why is there a discrepancy? Furthermore, the 713,960 acres is a very precise number considering the drainage boundaries of the subbasin are "difficult to distinguish" as indicated on page 3.

*10. Page 13, Recreational Problems Section - Page 14 indicates that "the total area of available surface water in lakes in the subbasin is approximately 918 acres." This does not constitute a lake region. If the number is correct then such references should be deleted. Is the total only 918 acres or is the area of lakes in which water-based recreation can be pursued a much larger figure? If so, this should be corrected.

11. Page 14, Water Supply Problems Section - Is the 918 figure correct?

*12. Page 16, Hydropower Section - The topography of the Red River basin does not preclude any future hydropower development. Such sites are quite limited; however, the National Hydropower Study did indicate a potential for hydropower development in various portions of the basin. The appropriate change should be made in this paragraph.

13. Page 17, Table 3, last column - What does "MNL" refer to?

*14. Page 18, 1st and 2nd paragraphs - The statement "...public perceptions of problems and solutions in the subbasin is fairly well defined..." is too strong of a statement about a meeting held in the area in 1971. The reasons for this are threefold:

1) Because 9 years have passed since this meeting, the public's perception of the problems and corresponding solutions may have changed.

2) Those attending the public meeting may not, and probably did not, represent the full range of opinions of the people in the subbasin.

3) How were the problems and solutions determined at the meeting? What techniques were used to measure the public's opinions? A public meeting format may not allow for specific assumptions to be made about public opinions. Because of the preceding discussion it is requested that this sentence be changed to read: "In 1971, the Corps of Engineers held a public meeting to begin to identify the public's perception of the problems and solutions in the subbasin." A public meeting or the establishment of a watershed district is not enough to identify the public perception of the problems and solutions. The interested and involved persons in the subbasin often attend meetings held throughout the basin. Their contribution to discussions helps us to understand the public perception which exists in the subbasin. Therefore, an appropriate modification should be made to this paragraph.

*15. Page 18, 2nd paragraph - Change the first sentence to read "The documents stated that the major concerns of the local people are the alleviation of flooding and improvement of surface drainage outlets..."

*16. Page 18, 3rd paragraph - Capitalize "Soil Conservation Districts."

*17. Page 18, 4th paragraph - After "the" and before "miles" add "317."

*18. Page 20, Social Characteristics Section - The migration of sugar beet field workers should be discussed. It should also be mentioned that the growth in Clay County is associated with the SMSA area of Fargo-Moorhead. Also, Georgetown should be identified.

19. Page 22, Income Section - The following should be considered to modify this section:

1) Is the percentage of increase in total personal income for the subbasin between 1977 and 1979 comparable to the percentage of increase in the State average total personal income?

2) What was the correction factor used to convert figures to 1979 dollars?

3) The State average of $8,341 differs from that shown in the Wild Rice - Marsh Rivers draft report.

20. Page 22, Agriculture Section - In addition to factors noted on yield per acre, harvested acres, and total production for particular crops, it would be helpful if income per acre for particular crops was included. This information would give a better understanding of the importance of each crop. One other factor which could be discussed that would aid in understanding flooding problems is the differential susceptibilities of crops to flood damages. Some crops are not as seriously affected by a flood as others.

*21. Page 23, Table 5 - The SIC code should be identified. Also, the estimated employment for the five types of industries is 175 persons. This is only a fraction of the almost 8,000 employed workers identified on page 21. Consequently, the table as presented is not very meaningful.

22. Page 24, last paragraph - Individual farmers, local elevators, and co-ops using fleets of trucks to fill the void created by rail shortages is true of several subbasins in the Red River of the North basin, according to statements made by farmers and truckers from the area. More discussion about this matter is needed in subsequent reports. In addition, the implications of this change in transportation should be discussed.

*23. Page 25, Land Use Section - The water and marsh areas are identified as having almost 4 percent of the total land area of the basin. Page 41 states that this figure should be 2.7 percent. Both of these greatly exceed the 918 acres previously identified. Careful review of the land use figures should be made for accuracy, and changes should be made as appropriate. Also, is the rest of the area urban? If so, this should be identified. Finally, are the last two sentences discussing the eastern and western areas, respectively?

*24. Page 27, last paragraph -

a) The proposed endangered butterfly should be named (Dakota Skipper).

b) All wetlands are in aquatic situations. The last two sentences on this page should be changed to read, "Wetlands afford cover, nutrients and breeding... invertebrates. When adjacent to upland areas, essential habitats..."

*25. Page 28, 2nd paragraph - The pheasant numbers of <5/100 miles are not adequately explained. This number is a population index based on the number of birds seen per 100 miles of survey transect. This index is useful for the relative comparison of populations between regions, but is not an indication of population numbers. More importantly, the population indexes cited for the pheasant and the ruffed grouse are relatively low when compared to other regions in Minnesota. To reflect this,

the report should be modified to read as follows:

"Although the pheasant and ruffed grouse are limited in numbers when compared to other regions in the State, they are the principal upland game birds in the region."

*26. Page 28, 2nd paragraph, 13th and 14th lines - Change "earthen" to "eastern." Also, identify Region 15 in the 14th line.

27. Page 28 and 29 - The paragraph on the flows of the North and South Branches of the Buffalo River is confusing and should be either rewritten or deleted with any information necessary included in the earlier part of the document.

28. Page 31, Water Supply Section - Georgetown should be identified.

29. Page 32, Table 7 - Again, the number of acres of lakes in the area does not agree with previous numbers.

*30. Page 37, 3rd and 4th paragraphs - Michlovic, 1978, is not listed in the bibliography. If this was a personal communication, it should be cited as such.

31. Page 38, paragraphs 2 and 3 - Sites which have nominations pending at the national level are listed in the Federal Register. If the nominations are at the State level, it should be indicated as such.

*32. Page 39, Social Section - Is Georgetown a population center of the subbasin?

*33. Page 41, Water Section - Reference comments #10, #23 and #29.

34. Pages 42 - 46 - The source of the information used for the wetland information is not adequately referenced in the bibliography. The information cited was in a separate letter report and not a part of the U.S. Fish and Wildlife Service 1980 Terrestrial Resources package that is referenced. This wetlands report should be cited separately: i.e., U.S. Fish and Wildlife Service. 1980 b. a letter report concerning wetland data for the Minnesota portion of the Red River of the North basin. Ecological Services. Office. St. Paul, 29pp.

*35. Page 43, Table 12 - This table is difficult to read. Change to same format as used in Table 13.

*36. Page 49, Figure V - Prairie is misspelled.

37. Page 55, Table 18 - What about average annual flood damages at Georgetown, Glyndon, and Hawley? Page 58 suggests that flood insurance or floodplain zoning programs are being implemented. Therefore, there must be a problem.

* 38. Page 57, 3rd paragraph - Add "The Corps of Engineers completed a Section 205 Reconnaissance Report in December 1978 for the Buffalo River at Georgetown. This report evaluated proposals of ring levees and a combination of ring levees and flood proofing in that community. No economically feasible solutions were found."

* 39. Page 58, 1st paragraph - The last sentence is too strong and should be deleted.

40. Page 58, Nonstructural Measures Section - Modify in accordance with Comment #2 provided by U.S. Army Corps of Engineers, North Central Division.

* 41. Page 60, 2nd paragraph - Between "appropriate" and "engineering" add "Federal."

* 42. Page 61 - Consideration should be given to wetland preservation.

* 43. Page 62, Structural Measures Section, 1.c. - Planned is misspelled.

44. Page 63, Figure VI - Delete escarpment symbol as it is confusing with other symbols.

* 45. Page 64, #2 - The objectives of "National Income" and "human well-being" should be changed to "national economic development" and "social well-being," respectively.

46. Page 64, items 2.a., b. and c. - Some of the information presented in these sections is an assessment of the alternatives. This type of information should be included in the assessment of alternatives section number IX.

47. Page 67, Nonstructural Measures Section - Flood proofing, floodplain evacuation, farmstead ring levees, flood insurance are all nonstructural measures which should be considered and discussed in this section.

48. Page 69, Table 19 - The alternatives should be numbered in accordance with the discussions. Also, the cost of $40,000/mile for alternative 2 seems low and should be reevaluated.

* 49. Pages 70 - 73, Impact Assessment Section - Discussions on cultural resources affected should be modified in accordance with general comment #5.

* 50. Page 71, Table 20 - Change "NE" under Cultural to "unknown."

* 51. Page 74, Evaluation Section - See general comment #4.

* 52. Page 75, #8 - Gaging is misspelled.

* 53. Page 76 - Add "consideration to combine the Buffalo-Red Watershed District with the Lower River Water Management Board."

* 54. Bibliography - "Michlovic, 1978" is not listed.

END

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6-84

DTIC